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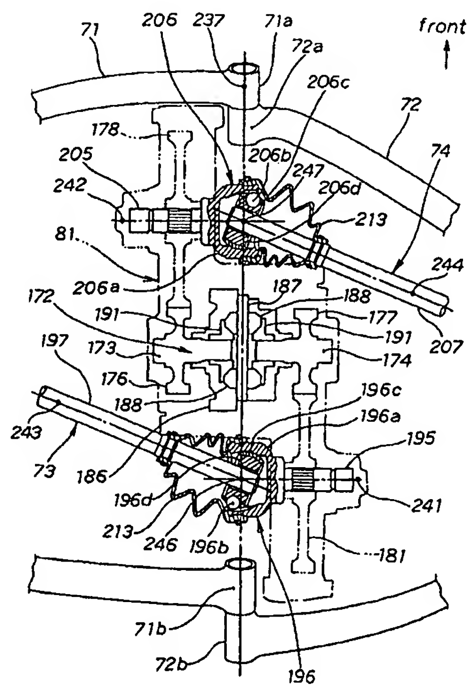
(54) Rocking vehicle

(57) The axial lines 241 and 242 of right and left internal shafts 195 and 205 are both intersected with a straight line 237 as a rocking axis, and the resulting intersection points 246 and 247 are placed at each different position.

Through coupling between the right and left internal shafts and rear wheels each via a drive shaft, the drive shafts do not displace that much even if the vehicle body frame rocks in the lateral direction. Further, for example, if the right and left internal shafts are placed away from each other in the front and rear of the vehicle body, the drive shaft can be placed extensively in the diagonal direction from the right and left internal shafts to the rear wheel side. As such, compared with a case where the right and left internal shafts are provided on the side part of the gearbox, the total length of the drive shaft can be increased in the present invention. In consideration thereof, the bending angle of the drive shaft can be suppressed small when the driving wheels move in the vertical direction, and what is better, the tread of the rear wheels can be reduced because the drive shaft is placed extensively in the diagonal direction even if it is long in total length.

Fig. 15



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Description

[0001] The present invention relates to a rocking vehicle in which a vehicle body frame can rock with respect to suspension arms by a rocking axis.

[0002] Known as a power transmission mechanism for a vehicle is the one with rear wheels attached at the tips of right and left axles that are concentrically extending from a differential gear to the right and left of the vehicle body (refer to JP-UM-B-63-21445 and JP-UM-B-59-106223 as examples).

[0003] Fig. 3 of JP-UM-B-63-21445 is described with Fig. 25 below. Here, reference numerals are changed from those original.

[0004] Fig. 25 is a plan view showing a power transmission mechanism of a conventional rocking vehicle. Shown therein is a vehicle in which an output of an engine 301 is transmitted to a differential gear 304 via chains 302 and 303, and rear wheels 307 and 307 are attached, respectively, at the tips of rear wheel axes 305 and 306 that are extending from the differential gear 304 to both sides thereof. With such a structure, the rear wheels 307 and 307 are driven.

[0005] Fig. 3 of JP-UM-B-59-106723 is described with Fig. 26 below. Here, reference numerals are changed from those original.

[0006] Fig. 26 is a cross-sectional view of a power transmission mechanism of a conventional rocking vehicle. Shown therein is a vehicle in which an engine 311 is coupled with an automatic belt-driven transmission 312, and a differential gear 314 accommodated in a rear axle 313 is coupled with the belt-driven automatic transmission 312 via gears and chains, and rear wheel axles 316 and 316 are attached, respectively, to the right and left sides of the differential gear 314, and rear wheels 317 and 317 are attached, respectively, to these rear wheel axles 316 and 316.

[0007] In the vehicle shown in Fig. 25 , the rear wheel axes 305 and 306 are extended, to right and left, from both side parts of the differential gear 304 to be coupled with the rear wheels 307 and 307. With such a placement, if the right and left rear wheels 307 and 307 are to be independently suspended, the right and left rear wheels 307 and 307 are each attached to the vehicle body side in such a manner as to move in the vertical direction via each corresponding suspension arm. And as the rear wheel axes 305 and 306, used is a drive shaft including a constant velocity joint, for example.

[0008] The drive shaft can transmit the driving forces to the rear wheels 307 and 307 even if the rear wheels 307 and 307 move in the vertical direction. For such transmission, however, the bending angle of the constant velocity joint being a part of the drive shaft has to be a predetermined angle or smaller. Accordingly, if the total length of the drive shaft is short, it will cause difficulty in reducing such a bending angle. In order to make the bending angle of the drive shaft equal to or smaller than the predetermined angle , there needs to increase the total length of the drive shaft. As a result, the distance between the centers of the right and left rear wheels, i.e., tread (tread (wheel base) denotes a horizontal distance between the centers of right and left tire tracks contacting the road surface) is increased, thereby rendering the vehicle wider. Thus, it is hardly applicable to small-sized vehicles, resultantly impairing the vehicle mobility. The same is true to the vehicle of Fig. 26 .

[0009] Therefore, an object of the present invention is, through improvement of a rocking vehicle, to reduce the tread of rear wheels while suppressing the bending angle of a drive shaft structuring a power transmission mechanism to be a predetermined angle or smaller.

[0010] To achieve the above object, Claim 1 is directed to a rocking vehicle in which a vehicle body frame is provided with a swing axis, right and left suspension arms are attached to the swing axis to freely swing, a driving wheel is attached to each of the suspension arms, the vehicle body frame is made rockable by a rocking arm with respect to the suspension arms, and an engine output is transferred to the right and left driving wheels via a transmission, a reduction gear, and right and left output axes provided to the reduction gear, characterized in that the right and left output axes both intersect with the rocking axis, and points of intersections are placed in each different position.

[0011] The right and left output axes both intersect with the rocking axis. Accordingly, through coupling between these right and left output axes and driving wheels via a drive shaft, the drive shaft does not displace that much even if the vehicle body frame rocks in the lateral direction. Further, intersection points of the right and left output axes and the rocking axis are placed in each different position. Accordingly, if the right and left output axes are so provided as to be away from each other in the front and rear of the vehicle body, for example, the drive shaft can be placed extensively in the diagonal direction from the right and left output axes to the driving wheel side. As such, compared with a case where the right and left output axes are provided on the side part of the transmission or the reduction gear, the total length of the drive shaft can be increased in the present invention. In consideration thereof, the bending angle of the drive shaft can be suppressed small when the driving wheels move in the vertical direction, and what is better, the tread of the driving wheels can be reduced because the drive shaft is placed extensively in the diagonal direction even if it is long in total length.

[0012] Claim 2 is characterized in that the driving wheel is coupled to the output axes via a drive shaft including a pair of constant velocity joints, and a bending part of the constant velocity joint on the side of the output axis is placed on the rocking axis.

[0013] By placing the bending part of the constant velocity joint on the side of the output axis on the rocking axis, even if the output axes tilt responding to the vehicle body rocking in the lateral direction, the constant velocity joint remains still. Thus, even if the drive shaft swings

together with the suspension arms, the bending angle of the constant velocity joint can be reduced.

[0014] Claim 3 is characterized in that the reduction gear includes a differential mechanism, and the right and left output axes are placed in the front and rear of the differential mechanism.

[0015] This allows easy connection of two axes on the output side of the differential mechanism to right and left output axes using a gear and others, thereby realizing the reduction gear compact in size.

[0016] Claim 4 is characterized in that the swing axis and the rocking axis are the same axis.

[0017] By structuring the swing axis and the rocking axis as one axis, the suspension arms can be shorter compared with a case where two swing axes are so provided as to be away from each other in the vehicle width direction. Accordingly, this reduces the tread of the right and left driving wheels, and narrows down the vehicle width. What is more, the number of components can be reduced, and cost reduction can be thus achieved.

[0018] Claim 5 is characterized in that a differential pinion axis structuring the differential mechanism passes through the rocking axis.

[0019] In a case of structuring the reduction gear including the differential mechanism to rock with the vehicle body frame, the differential pinion axis comes to the center of the differential mechanism. Thus, the inertial moment of the differential mechanism about the rocking axis can be reduced when the vehicle body frame rocks. As such, the vehicle body frame can rock with a quick motion, successfully increasing the mobility of the rocking vehicle.

[0020] Claim 6 is characterized in that, through placement of the engine, the transmission, the reduction gear, and the right and left output axes on the side of the vehicle body frame, these components structurally rock against the right and left driving wheels.

[0021] With such a structure having no engine, transmission, reduction gear, nor right and left output axes on the side of the suspension arms, when a suspension spring is provided on the side of the suspension arms, the unsprung weight can be considerably reduced. Accordingly, the ride comfort can be better to a greater degree.

[0022] Embodiments of the present invention are described below by referring to the accompanying figures 1-26. Note herein that the drawings are viewed from the direction same as the reference numerals. In the drawings,

Fig. 1
is a side view of a rocking vehicle of the present invention.

Fig. 2
is a side view showing the main part of a tricycle of the present invention.

Fig. 3
is a plan view of the tricycle of the present invention.

Fig. 4
is a side view showing the main part of the tricycle of the present invention.

Fig. 5
is a first perspective view of the tricycle of the present invention.

Fig. 6
is a back side view of the tricycle of the present invention.

Fig. 7
is a second perspective view of the tricycle of the present invention.

Fig. 8
shows diagrams illustrating a rocking mechanism of the present invention.

Fig. 9
is a third perspective view of the tricycle of the present invention.

Fig. 10
is a plan view of a vehicle body frame of the present invention.

Fig. 11
is a back side view of a rear suspension of the present invention.

Fig. 12
is a plan view showing the main part of a power transmission mechanism of the present invention.

Fig. 13
is a cross-sectional view illustrating a gearbox of the present invention.

Fig. 14
is a side view showing the gear train of the gearbox of the present invention.

Fig. 15
is a plan view showing the main part of the axial placement of the power transmission mechanism of the present invention.

Fig. 16
is a first effect view showing the effects achieved by the rear suspension of the present invention.

Fig. 17
is a second effect view showing the effects achieved by the rear suspension of the present invention.

Fig. 18
is a third effect view showing the effects achieved by the rear suspension of the present invention.

Fig. 19
is a fourth effect view showing the effects achieved by the rear suspension of the present invention.

Fig. 20
is a fifth effect view showing the effects achieved by the rear suspension of the present in-

vention.

Fig. 21
shows back side views for comparison of the total length of drive shaft.

Fig. 22
shows effect views illustrating the effects achieved by the drive shaft (example) of the present invention.

Fig. 23
shows effect views illustrating the effects achieved by the drive shaft of the comparative example.

Fig. 24
shows side views showing another embodiment of the gear train of the gearbox of the present invention.

Fig. 25
is a plan view showing the power transmission mechanism of a conventional vehicle.

Fig. 26
is a cross-sectional view showing the power transmission mechanism of another conventional vehicle.

[0023] Fig. 1 is a side view of a rocking vehicle according to the present invention. Therein, a tricycle 10 with a rocking mechanism as a rocking vehicle (hereinafter, referred to as "tricycle 10") is a vehicle that is provided with: a front fork 12 attached to a head pipe 11 via a not-shown handle axis to be steerable; a front wheel 13 attached to the lower end of the front fork 12; a handle 14 attached to the front fork 12 to be a unit therewith; a vehicle body frame 16 attached to the rear part of the head pipe 11; a power unit 17 attached to the rear part of the vehicle body frame 16; rear wheels 18 and 21 (rear wheel 21 locating back behind is not shown) as driving wheels driven by the power unit 17; a housing box 22 attached to the upper part of the vehicle body frame 16; and a seat 23 attached to the upper part of the housing box 22 to freely open or close.

[0024] The vehicle body frame 16 is structured by a down pipe 25 extending downward toward the rear from the head pipe 11; a pair of right and left lower pipes 26 and 27 (lower pipe 27 locating back behind is not shown) extending toward the rear and then upward toward the rear from the lower part of the down pipe 25; a center upper frame 28 coupled to the rear parts of these lower pipes 26 and 27; a center pipe 31 extending toward the rear from the down pipe 25 to be coupled to the center upper frame 28; and a J frame 32 in the shape of letter J viewed from the side, being coupled to the rear parts of the lower pipes 26 and 27 and the rear side part of the center upper frame 28.

[0025] The center upper frame 28 is a member provided for supporting the housing box 22, and for suspending the power unit 17.

[0026] The J frame 32 is a member provided for attaching a rear suspension suspending the rear wheels 18 and 21, and a rocking mechanism with which the side of the vehicle body frame 16 can rock in the lateral direction with respect to the side of the rear suspension. Such rear suspension and rock mechanism will be described in more detail later.

[0027] The power unit 17 is structured by an engine 34 placed toward the front of the vehicle body, and a power transmission mechanism 35 for transmitting the power of the engine 34 to the rear wheels 18 and 21.

[0028] Here, 41 denotes a front fender covering the upper part of the front wheel 13, 42 a battery, 43 a winker, 44 a taillight, 46 an air cleaner, and 47 a muffler.

[0029] Fig. 2 is a side view showing the main part of the tricycle according to the present invention. Therein, coupling pipes 52 and 52 (coupling pipe 52 locating back behind is not shown) are placed across both the J frame 32 and the center upper frame 28 to couple together the upper part of the J frame 32 and the rear end of the center upper frame 28, reinforcing plates 53 and 53 (reinforcing plate 53 locating back behind is not shown) are attached to the coupling pipes 52 and 52 and the center upper frame 28, an L pipe 54 almost in the shape of letter L viewed from the side is attached to the inside of the rear part of the J frame 32, brackets 56 and 56 (bracket 56 locating back behind is not shown) are attached to the center upper frame 28, the front upper part of the power unit 17 is attached to the brackets 56 and 56 via a bridge member 57, the rear part of the power unit 17 is supported by extending a supporting rod 58 downward toward the rear from the reinforcing plates 53 and 53, and the rear end part of the power unit 17 is attached by extending a protruding section 61 from the front part of the L pipe 54 toward the front. Herein, in the J frame 32, 32A, 32B, and 32C denote, respectively, a lower part horizontal section being almost horizontal, a rear end slanting section in which the upper end side is moved rearward than the lower end side, and an upper part slanting section in which the front end part is moved upward than the rear end part.

[0030] Fig. 3 is a plan view of the tricycle according to the present invention. Therein, the rear part of the J frame 32 is structured by a single pipe, and to the J frame 32, a rear suspension 63 (will be described in detail later) is attached. Note here that 65 denotes a brake lever for the rear wheels, and 66 denotes a brake lever for the front wheel.

[0031] Fig. 4 is a plan view showing the main part of the tricycle according to the present invention. Shown therein is the structure in which suspension arms 71 and 72 are attached to both sides of the J frame 32, a holder (not shown) is attached to at each tip of the suspension arms 71 and 72, the rear wheels 18 and 21 are respectively attached to the holders to be rotatable, and the rear wheels 18 and 21 are driven by drive shafts 73 and 74 structuring the power transmission mechanism 35 of the power unit 17.

[0032] 76 denotes a buffer as elastic means including a damper 77 and a compressed coil spring (not shown), and is coupled to both sides of the right and left suspen-

sion arms 71 and 72.

[0033] The center upper frame 28 is a member in the shape of almost oval, and attached to the upper part thereof is the housing box 22 (refer to Fig. 1) whose bottom is almost the same shape.

[0034] The power transmission mechanism 35 of the power unit 17 is structured by: a belt-driven continuously variable transmission 78 extending from the left rear part of the engine 34 toward the rear, a gearbox 81 as a reduction gear coupled to the rear part of the continuously variable transmission 78, and a drive shaft 74 connected to an output axis locating in the front side of the gearbox 81 and a drive shaft 73 connected to an output axis locating in the rear side of the gearbox 81.

[0035] Fig. 5 is a first perspective view of the tricycle according to the present invention, and shows that the rear parts of the lower pipes 26 and 27 of the vehicle body frame 16 are attached with the front part of the J frame 32. Herein, 83 denotes a holder (another holder 83 locating back behind is not shown).

[0036] Fig. 6 shows a back side view of the tricycle according to the present invention. Therein, the rear end slanting section 32B of the J frame 32 is a part being almost vertical when nobody is on the tricycle 10, and to this rear end slanting section 32B, the rear parts of the suspension arms 71 and 72 are attached. Herein, 85 denotes a rear part swing axis for attaching the rear parts of the suspension arms 71 and 72 to the rear end slanting section 32B to freely swing.

[0037] Fig. 7 is a second perspective view of the tricycle according to the present invention. Therein, shown is the rear suspension 63 in which the suspension arms 71 and 72 are extended to both sides from the J frame 32, the holder 83 is each attached to the tips of the suspension arms 71 and 72, arc-shaped links 88 and 89 are attached to the upper parts of the suspension arms 71 and 72 via attachment brackets 86 and 87 to freely swing, bell cranks 90 and 91 in the shape of almost letter L viewed from the side are attached to the tips of the arc-shaped links 88 and 89 to freely swing, a buffer 76 is placed across between the upper end parts of the bell cranks 90 and 91, a bar-shaped connection member 92 is placed across the side end parts of the bell cranks 90 and 91, and the connection member 92 is attached to the rear end slanting section 32B of the J frame 32 via a rocking mechanism 93.

[0038] The arc-shaped links 88 and 89 are each provided, at the center, with a side protruding section 95, and the side protruding sections 95 are attached, respectively, with brake calipers 96 and 96 for braking the arc-shaped links 88 and 89 not to swing. Herein, 97 and 97 both denote a brake unit including the brake caliper 96 for sandwiching any corresponding disk 98 or 98 by the corresponding brake caliper 96 or 96 responding to hydraulic pressure. The disks 98 and 98 are both a member attached to the suspension arms 71 and 72, respectively. 100 denotes a bolt to serve as a swing axis of the arc-shaped links 88 and 89.

[0039] The bell cranks 90 and 91 are each structured by two crank plates 102 and 102, and including a first bolt 103, a second bolt 104, and a third bolt 106. Here, 107 denotes a fourth bolt serves as a stopper pin for controlling the expansion and contraction of the buffer 76, and 108 ... (... indicates the plural provision, and the same is applicable to below) denote nuts screwed into the first to fourth bolts 103 to 107.

[0040] The rocking mechanism 93 is so structured as to allow the vehicle body frame 16 to rock in the lateral direction with respect to the suspension arms 71 and 72 at the time of cornering and others, and as the rocking angle is increased, the kickback reaction is increased with the internal elastic body to put it back to the original position.

[0041] Figs. 8(a) to (c) are all a diagram illustrating the rocking mechanism according to the present invention. Specifically, (a) is a side view (partially cross-sectional view), (b) is a cross-sectional view cut along line b-b, and (c) is a diagram showing the effects derived based on (b).

[0042] In (a), the rocking mechanism 93 is a so-called "Neidhardt damper", structured by a case 111 attached to both the rear end slanting section 32B of the J frame 32 and the rear part of the L pipe 54, damper rubbers 112 ... accommodated in the case 111, a thrust member 113 attached to the connection member 92 while thrusting these damper rubbers 112 ..., and a through pin 116 going through the thrust member 113 and the connection member 92, and both end parts thereof are supported by a tip support section 114 provided to the L pipe 54 and the rear end slanting section 32B. Herein, 117 denotes an attachment section provided to the thrust member 113 for attachment of the thrust member 113 using a bolt to the connection member 92, and 118 denotes a swing control section provided to be a piece with the tip support section 114 for controlling the swing amount of the connection member 92.

[0043] In (b), the case 111 is a combined member of a left case 121 and a right case 122. Therein, a damper accommodation chamber 123 is provided, and at four corners of this damper accommodation chamber 123, the damper rubbers 112 ... are placed, and these damper rubbers 112 ... are thrusted by convex thrust sections 124 ... of the thrust member 113.

[0044] In (c), the vehicle body frame 16 rocks toward the left of the vehicle body (arrow left in the drawing denotes left side of the vehicle body) with respect to the connection member 92 coupled to the side of the suspension arms. Responding to the L pipe 54 tilting by an angle θ, the case 111 of the rocking mechanism 93 rotates relatively to the thrust member 113. The damper rubbers 112 ... accommodated in the case 111 are compressed by the case 111 and the thrust member 113 sandwiched therebetween. Accordingly, the kickback reaction occurs to put the case 111, and by extension, the vehicle body frame 16 back to the original position (position of (a)).

[0045] Fig. 9 is a third perspective view of the tricycle according to the present invention (diagram viewing the vehicle body frame from diagonally therebehind). Shown therein is the J frame 32 including a rear part attachment section 127 provided for attaching the rear parts of the suspension arms 71 and 72 (refer to Fig. 7) to freely swing, and a front part attachment section 128 provided for attaching the front parts of the suspension arms 71 and 72 to freely swing.

[0046] The rear part attachment section 127 is structured by the rear end slanting section 32B, and a vertical bracket 131 provided vertically from the L pipe 54 to a lower part horizontal section 32E (will be described later). To each of the rear part slanting section 32B and the vertical bracket 131, the rear part swing axis 85 is attached for supporting the rear parts of the suspension arms 71 and 72.

[0047] The front part attachment section 128 is structured by a front part rising section 133 and a rear part rising section 134 provided to the lower part horizontal section 32E with some interval therebetween to rise. To each of the front part rising section 133 and the rear part rising section 134, a front part swing axis 136 is attached for supporting the front parts of the suspension arms 71 and 72.

[0048] The front part swing axis 136 and the rear part swing axis 85 described above are also swing axes of the suspension arms 71 and 72, and rocking axes of the vehicle body frame 16.

[0049] Here, 138 denotes a fuel tank, and 144 denotes a U-shaped U pipe attached to the lower rear parts of the lower pipes 26 and 27 for attaching the tip of the lower part horizontal section 32E of the J frame 32.

[0050] Fig. 5 shows the embodiment in which the front end of the lower part horizontal section 32A bifurcated into Y-shape is directly attached to the lower pipes 26 and 27. In Fig. 9, shown is another embodiment in which the J frame 32 is structured by the lower part horizontal section 32E bifurcated into Y-shape, the rear end slanting section 32B, and the upper part slanting section 32C. The front end of the lower part horizontal section 32E is attached to the lower pipes 26 and 27 via the U pipe 144, or an engine attachment section in the vehicle body frame 16 is structured as engine mount vibration isolation links 142 and 143.

[0051] Fig. 10 is a plan view of the vehicle body frame acco rding to the present invention. Shown therein is the J frame 32 in which the lower part horizontal section 32E is bifurcated into Y-shape at some point thereof to couple to the rear part of the U pipe 144, and the coupling pipes 52 and 52 are extended, in the shape of Y, from the upper part slanting section 32C of the J frame 32 to the center upper frame 28.

[0052] The lower part horizontal section 32E (and lower part horizontal section 32A (refer to Fig. 5)) is a part, in detail, formed by bending a long first pipe 151 at some point thereof, and in the vicinity of the resulting bending part 152 of the first pipe 151, a second pipe 153 is connected. Here, 154 denotes a Y bifurcation section bifurcated into Y-shape through connection between the first pipe 151 and the second pipe 153, and 155 denotes another Y bifurcation section bifurcated into Y-shape through connection between the upper part slanting section 32C and the coupling pipes 52 and 52.

[0053] The first pipe 151 is a member including the rear end slanting section 32B and the upper part slanting section 32C, and is the one derived by excluding the second pipe 153 from the J frame 32.

[0054] As such, by forming the lower part horizontal section 32E in the shape of Y, coupling between the lower front part of the J frame 32 and the U pipe 144 can be securely fastened. And by placing the coupling pipes 52 and 52 in the shape of Y, coupling between the rear upper part of the J frame 32 and the rear part of the center upper frame 28 can be securely fastened. Further, in Fig. 5, by shaping the lower part horizontal section 32A in the Y shape, coupling between the lower front part of the J frame 32 and the lower pipes 26 and 27 can be securely fastened.

[0055] Fig. 11 is a back side view of the rear suspension according to the present invention, and shown therein is the rear suspension 63 on which a passenger (driver) is sitting (such a state is referred to "1G state"). Herein, the rear end slanting section 32B and the upper part slanting section 32C in the J frame 32 of Fig. 9 are not shown. Further, the right case 122 of the rocking mechanism 93 of Fig. 8(b) is indicated by imaginary lines. In such a case, the L pipe 54 of the vehicle body frame 16 is almost vertical, and the connection member 92 is almost horizontal.

[0056] The connection member 92 is a member including, at both ends, fan-shaped sections 156 and 157 both being in the shape of a fan, and these fan-shaped sections 156 and 157 are formed with arc-shaped long holes 158 and 159, respectively. Through these arc-shaped long holes 158 and 159, fourth bolts 107 and 107 serving as stopper pins are each inserted, thereby controlling the tilting angle of the bell cranks 90 and 91 with respect to the connection member 92. The tilting angle of the bell cranks 90 and 91 changes depending on the tilting angle of the suspension arms 71 and 72, i. e. , how much the rear wheels 18 and 21 move in the vertical direction. In other words, the arc-shaped long holes 158 and 159 are parts with which the rear wheels 18 and 21 are restricted to move in the vertical direction.

[0057] Fig. 12 is a plan view showing the main part of the power transmission mechanism according to the present invention. Shown therein is the power transmission mechanism 35 in which the rear part of a crankcase 34a of the engine 34 accommodates the continuously variable transmission 78, and at the rear part of the crankcase 34a, the gearbox 81 is attached separately from the crankcase 34a.

[0058] The crankcase 34a is structured by a case body 34b, a transmission cover 34c covering the left side of the case body 34b, and a right cover 34d cover-

ing the right side of the case body 34b.

[0059] The gearbox 81 includes a gear case 165 for accommodating a plurality of gears, and the gear case 165 is structured by first to fourth cases 166 to 169.

[0060] Fig. 13 is a cross-sectional view illustrating the gearbox according to the present invention. The gearbox 81 is provided with: a differential mechanism 172, a first left gear 176 and a first right gear 177 formed to be a piece with, respectively, a left differential axis 173 and a right differential axis 174 both being an output of the differential mechanism 172; a second left gear 178 and a second right gear 181 engaged with the first left gear 176 and the first right gear 177, respectively; the above-described gear case 165; a plurality of bearings; and bolts 182 ... and 183 ... used for coupling the cases of the gear case 165. Herein, 184 and 184 each denote a cap closing the opening aperture of the first case 166 and the fourth case 169.

[0061] The differential mechanism 172 is structured by: a case 186, a pin 187 as a differential pinion axis attached to the case 186; a pair of first bevel gears 188 and 188 both attached to the pin 187 to be rotatable; a pair of second bevel gears 191 and 191 engaged respectively with these first bevel gears 188 and 188; and the above-described left differential axis 173 and right differential axis 174 establishing spline coupling with these second bevel gears 191 and 191.

[0062] The case 186 is structured by a case body section 186a, and a case cover section 186b closing the opening aperture of the case body section 186a. To the case body section 186a, provided is a large-diameter gear 186c for receiving the power from the side of the continuously variable transmission 78. The case body section accommodates the first bevel gears 188 and 188, and the second bevel gears 191 and 191.

[0063] The drive shaft 73 is structured by: an internal shaft 195 as an output axis establishing spline coupling with the second right gear 181; a center shaft 197 coupled to the internal shaft 195 via a constant velocity joint 196; and an external shaft 201 being coupled to the tip of the center shaft 197 via the constant velocity joint 198, and establishing spline coupling with the hub on the side of the rear wheel 18.

[0064] The drive shaft 74 is structured by: an internal shaft 205 as an output axis establishing spline coupling with the second left gear 178; a center shaft 207 coupled to the internal shaft 205 via a constant velocity joint 206; and an external shaft 211 being coupled to the tip of the center shaft 207 via the constant velocity joint 208, and establishing spline coupling with the hub on the side of the rear wheel 21. Herein, 212 and 212 both denote a nut for fixing the internal shafts 195 and 205 to the second left gear 178 and the second right gear 181, respectively; 213 ... each denote a rubber boot covering the constant velocity joints 196, 198, 206, and 208; and 214 and 214 both denote a nut for fixing the external shafts 201 and 211 to the hub.

[0065] The internal shaft 195 of the above-described drive shaft 73 is a left output axis of the gearbox 81, and the internal shaft 205 of the drive shaft 74 is a right output axis of the gearbox 81.

[0066] As such, in the present invention, the internal shafts 195 and 205 as the right and left output axes of the gearbox 81 are so provided as to be away from each other in the fore and aft direction of the vehicle body.

[0067] Fig. 14 is a side view of a gear train of the gearbox according to the present invention. Therein, a driving gear 221 is attached to a follower pulley axis of the belt-driven continuously variable transmission 78, the driving gear 221 is engaged with a large gear 223 being a part of a reduction gear 222, a transmission gear 226 is engaged with a small gear 224 being a unit with the large gear 223, the transmission gear 226 is engaged with the large-diameter gear 186c of the differential mechanism 172, the second left gear 178 is engaged with the first left gear 176 of the left differential axis 173 (refer to Fig. 13) coaxial to the large-diameter gear 186c, the second right gear 181 is engaged with the first right gear 177 of the right differential axis 174 (refer to Fig. 13) coaxial also to the large-diameter gear 186c, the differential mechanism 172, specifically, the first left gear 176 and the first right gear 177 are located below to the continuously variable transmission 78. Herein, 231 to 236 each indicate the rotation center of the respective gears, and the distance between the rotation centers 234 and 236 is presumably D1.

[0068] Fig. 14 also shows that the rotation centers 234, 235, and 236 are located on a straight line 237, and on this straight line 237, the front part swing axis 136 and the rear part swing axis 85 are placed. The front part swing axis 136 is attached, to be rotatable, with the front part attachment sections 71a and 72a of the suspension arms 71 and 72, respectively. The rear part swing axis 85 is attached, to be rotatable, with the rear part attachment sections 71b and 72b of the suspension arms 71 and 72, respectively.

[0069] That is, in the front and rear of the differential mechanism 172, placed are the front part attachment sections 71a and 72a and the rear part attachment sections 71b and 72b of the suspension arms 71 and 72.

[0070] The above-described straight line 237 is a swing axis of the suspension arms 71 and 72 of Fig. 11, and also a rocking axis of the vehicle body 16.

[0071] Fig. 15 is a plan view mainly showing the axial placement in the power transmission mechanism according to the present invention. Illustrated therein are the internal shafts 195 and 205 as right and left output axes of the gearbox 81, and the bending parts of the drive shafts 73 and 74, and the swing axes of the suspension arms 71 and 72. Herein, an arrow (front) in the drawing indicates the front of the vehicle.

[0072] Assuming that the axial lines of the internal shafts 195 and 205 are axial lines 241 and 242, the axial lines of the center shafts 197 and 207 are axial lines 243 and 244, the axial line of the internal shaft 195 intersects with the axial line 243 of the center shaft 197 at an in-

tersection point 246, and the axial line 242 of the internal shaft 205 intersects with the axial line 244 of the center shaft 207 at an intersection point 247, those intersection points 246 and 247 intersect with the swing axes of the suspension arms 71 and 72, and the straight line 237 being a rocking axis of the vehicle body frame 16 (refer to Fig. 11).

[0073] Such intersection points 246 and 247 are also bending parts of the constant velocity joints 196 and 206.

[0074] Here, in the constant velocity joints 196 and 206, 196a and 206a denote outer rings formed to be a unit with the internal shafts 195 and 205, respectively, 196b ... and 206b ... (the drawing shows only one of each) denote balls movable in the groove provided to the inner planes of the outer rings 196a and 206a, respectively, 196c and 206c denote cages for retaining therein the balls 196b ... and 206b ... not to loosen, and 196d and 206d both denote internal rings being fit to the inner planes of the cages 196c and 206c, allowing spline engagement at the tips of the center shafts 197 and 207, and having concave parts for the balls 196b and 206b fit therein.

[0075] As such, by placing the bending parts of the constant velocity joints 196 and 206 on the straight line 237, in the drive shafts 73 and 74, only the internal shafts 195 and 205 rock together with the gearbox 81 but not the center shafts 197 and 207 and the external shafts 201 and 211 (refer to Fig. 13) when the vehicle body frame 16 rocks in the lateral direction. That is, this prevents the drive shafts 73 and 74 from displacing.

[0076] By referring to Fig. 23, an exemplary comparison case is described where the bending part of the constant velocity joint is not placed on the swing axis of the suspension arms (or on the rocking axis of the vehicle body frame).

[0077] The drawing also shows that the pin 187 serving as the differential pinion axis structuring the differential mechanism 172 passes through the above-described straight line. The pin 187 is the one placed in the center of the differential mechanism 172, and by extension, is the one placed in the center of the gearbox 81. In other words, the differential mechanism 172 is placed on the straight line 237, and by extension, the gearbox 81 is placed on the straight line.

[0078] Accordingly, even if the differential mechanism 172 weighing a lot among the constituents of the gearbox 81 rocks together with the vehicle body frame 16 about the straight line 237, the mobility of the tricycle 10 with the rocking mechanism can be improved to a greater degree. This is because the inertial moment of the differential mechanism 172 about the straight line 237 being the rotation axis can be reduced (and the inertial moment of the gearbox 81 can be reduced), and the tricycle 10 with the rocking mechanism (refer to Fig. 1) can make a turn with a quick motion by rocking to the left or right.

[0079] Described next is the effects of the rear suspension 63.

[0080] Fig. 16 is a first effect diagram showing the effects achieved by the rear suspension according to the present invention.

[0081] For example, if the left rear wheel 18 moves upward by an amount of motion M1 from the state shown in Fig. 11, the suspension arm 71 accordingly swings upward as indicated by an arrow a about the rear part swing axis 85 and the front part swing axis 136 (refer to Fig. 9), and responding thereto, the arc-shaped link 88 moves upward as an arrow b. This causes the bell crank 90 to swing in the direction of arrow c while the second bolt 104 serving as a fulcrum, whereby the buffer 76 is compressed as an arrow d. In such a manner, impact resulting from rising of the left rear wheel 18 to the side of the vehicle body frame 16 (refer to Fig. 10) is lessened.

[0082] At this time, the other suspension arm 72 is in the same state as that of Fig. 11, thus the connection member 92 is almost horizontal similarly to Fig. 11.

[0083] Fig. 17 is a second effect diagram showing the effects achieved by the rear suspension according to the present invention.

[0084] From the state of Fig. 11, the rear wheels 18 and 21 both move upward by an amount of motion M2. Or, if the vehicle body frame 16 moves downward with respect to the rear wheels 18 and 21 by the amount of motion M2, the suspension arms 71 and 72 both swing upward as arrows f and f about the rear part swing axis 85 and the front part swing axis 136 (refer to Fig. 9). In response thereto, the arc-shaped links 88 and 89 move upward as arrows g and g. This causes the bell cranks 90 and 91 to swing in the direction of arrows h and h while the second bolt 104 serving as a fulcrum, whereby the buffer 76 is compressed as arrows j and j. In such a manner, buffering effects can be provided by the buffer 76.

[0085] Fig. 18 is a third effect diagram showing the effects achieved by the rear suspension according to the present invention.

[0086] From the state of Fig. 11, the rear wheels 18 and 21 both move downward by an amount of motion M3. Or, if the vehicle body frame 16 moves upward with respect to the rear wheels 18 and 21 by the amount of motion M3, the suspension arms 71 and 72 both swing downward as arrows m and m about the rear part swing axis 85 and the front part swing axis 136 (refer to Fig. 9). In response thereto, the arc-shaped links 88 and 89 accordingly move downward as arrows n and n. This causes the bell cranks 90 and 91 to swing in the direction of arrows p and p while the second bolt 104 serving as a fulcrum, whereby the buffer 76 is extended as arrows q and q. In such a manner, buffering effects can be provided by the buffer 76.

[0087] Fig. 19 is a fourth effect diagram showing the effects achieved by the rear suspension according to the present invention.

[0088] From the state of Fig. 11, when the vehicle

body frame 16, in this example, the L pipe 54 rocks towards the left of the vehicle body by an angle of $\phi 1$, the connection member 92 coupled to the L pipe 54 using the through pin 116 moves horizontally toward the left as indicated by an arrow s. In response thereto, the arc-shaped links 88 and 89 both tilt as indicated by arrows t and t, and the bell cranks both move horizontally in the direction of arrows u and u. Here, the distance between the third bolts 106 and 106 of the bell cranks 90 and 91 shows no change, thus the buffer does not expand nor contract.

[0089] At this time, the vehicle body frame 16 rocks with respect to the connection member 92. Thus, similarly to the case of Fig. 8(c), the kickback reaction occurs by the rocking mechanism to put the vehicle body frame 16 back to its original position (that is, position of Fig. 11).

[0090] Fig. 20 is a fifth effect diagram showing the effects achieved by the rear suspension according to the present invention.

[0091] From the state of Fig. 11, when the rear wheel 18 moves upward by an amount of motion M4, and the vehicle body frame 16, in this example, the L pipe 54 rocks towards the left of the vehicle body by an angle of $\phi 2$, the suspension arm 71 swings upward as an arrow v about the rear part swing axis 85 and the front part swing axis 136 (refer to Fig. 9), and the connection member 92 moves toward the left as indicated by an arrow w. In response thereto, the arc-shaped link 88 moves upward and tilts toward the left, and the arc-shaped link 89 tilts leftward as indicated by an arrow x. The bell crank 90 swings clockwise while the second bolt 104 serving as a fulcrum, and moves toward left. The bell crank 91 moves leftward, and resultantly compresses the buffer 76. As such, the buffer effects can be achieved.

[0092] Figs. 21(a) and (b) are both a back side view provided for the comparison purpose of total length of the drive shaft, and specifically, (a) shows an example (present embodiment), and (b) shows a comparative example.

[0093] In the example of (a), one end of the drive shaft 73 is attached to the third and fourth cases 168 and 169 provided on the right side of the gearbox 81, and an end of the drive shaft 74 is attached to the first and second cases 166 and 167 provided on the left side of the gearbox 81. In the drawing, circle marks denote constant velocity joints 196, 198, 206, and 208. Herein, the distance LL1 between the constant velocity joints 196 and 198 is presumably the total length of the drive shaft 73.

[0094] In the comparative example of (b), an end of a left drive shaft 352 is attached to the left side of a gearbox 351, and an end of a right drive shaft 353 is attached to the right side of the gearbox 351. In the drawing, circle marks denote constant velocity joints 355, 356, 357, and 358. Herein, the distance LL2 between the constant velocity joints 355 and 356 is presumably the total length of the drive shaft 352. Note that, 361 and 362 both denote a rear wheel, 363 and 364 both denote a suspension arm, and 365 denotes a vehicle body frame.

[0095] In the above (a) and (b), LL1 > LL2.

[0096] Described next are the effects of the drive shafts 73 and 74, the left drive shaft 352, and the right drive shaft 353 described in the above.

[0097] Figs. 22(a) to (c) are all an effect diagram illustrating the effects achieved by the drive shaft (example) according to the present invention.

[0098] In (a), when the left rear wheel 18 moves upward by the amount of motion M1, the drive shaft 73 bends at the constant velocity joint 196, and the resulting bending angle will be $\alpha 1$.

[0099] In (b), when the vehicle body frame 16 rocks toward the left side of the vehicle body by an angle of $\phi 1$, the gearbox 81 rocks together therewith. The drive shaft 73 bends at the constant velocity 196, and the resulting angle will be $\alpha 2$.

[0100] In (c), when the rear wheel 18 moves upward by the amount of motion M4, and when the vehicle body frame 16 rocks toward the left of the vehicle body by an angle of $\phi 2$, the gearbox 81 rocks together therewith. The drive shaft 73 bends at the constant velocity joint 196, and the resulting angle will be $\alpha 3$. This bending angle $\alpha 3$ is in the acceptable range for bending of the constant velocity joint 196.

[0101] Figs. 23 (a) to (c) are all an effect diagram illustrating the effects achieved by the drive shaft in the comparative example.

[0102] In (a), when the left rear wheel 361 moves upward by the amount of motion M1, the left drive shaft 352 bends at the constant velocity joint 356, and the resulting bending angle will be $\beta 1$.

[0103] In (b), when the vehicle body frame 365 rocks toward the left side of the vehicle body by an angle of $\phi 1$, the gearbox 351 rocks together therewith. The drive shaft 352 bends at the constant velocity joint 356, and the resulting angle will be $\beta 2$.

[0104] In (c), when the rear wheel 361 moves upward by the amount of motion M4, and when the vehicle body frame 365 rocks toward the left of the vehicle body by an angle of $\phi 2$, the gearbox 351 rocks together therewith. The drive shaft 352 bends at the constant velocity joint 356, and the resulting angle will be $\beta 3$.

[0105] This bending angle $\beta 3$ will show $\beta 3 > \alpha 3$ in comparison with the bending angle $\alpha 3$ of Fig. 22(c).

[0106] Here, to make the bending angle $\beta 3$ to be the bending angle $\alpha 3$, there needs to increase the total length of the drive shaft (reference numeral thereof is 352a) to be LL3. It means the vehicle width is increased.

[0107] In consideration thereof, in the present invention, as described by referring to Fig. 13, the coupling positions of the drive shafts 73 and 74 to the gearbox 81 are offset against the front and rear of the line connecting the axles with the rear wheel 18 and the rear wheel 21 (i.e., external shafts 201 and 211). This allows diagonal placement of the drive shafts 73 and 74 in the vehicle width direction. As a result, in spite of increasing

the total length of the drive shafts 73 and 74, the treads of the rear wheels 18 and 21 can be reduced.

[0108] The comparative examples shown in Figs. 2 3 (a) to (c) are those in which the rocking axis 367 of the vehicle body frame 365 does not coincide with the bending part of the left drive shaft 352 (i.e., constant velocity joint 356 in the drawing). The example shown in Figs. 22 (a) to (c) are those in which the bending part of the drive shaft 73 (i.e., constant velocity joint 196 in the drawing) is placed on the rocking axis of the vehicle body frame 16. As such, the example in which the bending part is placed on the rocking axis shows the smaller bending angle of the constant velocity joint, and the thread of the rear wheel can be smaller.

[0109] Further, in comparison with Fig. 22(b) and Fig. 23(b), the center shaft of the drive shaft 73 remains still in the example even if the vehicle body frame 16 rocks, and in the comparative example, the center shaft of the left drive shaft 352 swings about the constant velocity joint 355 when the vehicle body frame 365 rocks. As a result, by the inertial moment of the center shaft, there needs larger external forces to swing the vehicle body frame 365. Accordingly, this impairs the mobility of the rocking vehicle.

[0110] As described by referring to Figs. 9, 12, and 15, the present invention is directed to, first, the tricycle 10 with the rocking mechanism (refer to Fig. 1) in which the vehicle body frame 16 is provided with the front part swing axis 136 and the rear part swing axis 85 (refer to Fig. 7), and to these swing axes 136 and 85, the right and left suspension arms 71 and 72 are attached to freely swing. To these suspension arms 71 and 72, the rear wheels 18 and 21 are attached to make the vehicle body frame 16 swingable by the rocking axes, i.e., the swing axes 136 and 85, with respect to the suspension arms 71 and 72. Further, the engine output is transferred to the right and left rear wheels 18 and 21 via the continuously variable transmission 78, the gearbox 81, and the right and left internal shafts 195 and 205 provided to the gearbox 81, characterized in that the axial lines 241 and 242 of the right and left internal shafts 195 and 205 are both intersected with the straight line 237 serving as the rocking axis, and the resulting intersection points 246 and 247 are placed at each different position.

[0111] By the axial lines 241 and 242 of the right and left internal shafts 195 and 205 intersecting with the straight line 237, when the right and left internal shafts 195 and 205 are coupled with the rear wheels 18 and 21 via the drive shafts 73 and 74, respectively, the drive shafts 73 and 74 do not displace that much even if the vehicle body frame 16 rocks in the lateral direction. What is better, by placing the intersection points 246 and 247 of the right and left internal shafts 195 and 205 with the straight line 237 at each different position, for example, in the present invention, the drive shafts 73 and 74 can be placed extensively in the diagonal direction from the right and left internal shafts 195 and 205 toward the rear wheels 18 and 21 if the right and left internal shafts 195 and 205 are placed to be away from each other in the fore and aft direction of the vehicle body. In this case, compared with the case where the right and left internal shafts 195 and 205 on the side part of the continuously variable transmission 78 or the gearbox 81, the drive shafts 73 and 74 can be increased in total length. As is known from the above, the bending angles of the drive shafts 73 and 74 can be suppressed small when the rear wheels 18 and 21 move in the vertical direction. What is better, the rear wheels 18 and 21 can be smaller in tread because the drive shafts 73 and 74 are placed extensively in the diagonal direction even if long in total length. Accordingly, these contribute to reduce the width of the vehicle.

[0112] Second, the present invention is characterized in that the rear wheels 18 and 21 are coupled to the internal shafts 195 and 205 via the drive shaft 73 including a pair of constant velocity joints 196 and 198 (refer to Fig. 13) and the drive shaft 74 including a pair of constant velocity joints 206 and 208 (refer to Fig. 13). In detail, the internal shafts 195 and 205 of the drive shafts 73 and 74 serve as output axes, and the bending parts of the constant velocity joints 196 and 206 on the side of the internal shafts 195 and 205, i.e., the intersection points 246 and 247, are placed on the straight line 237.

[0113] By such a placement of the constant velocity joints 196 and 206 on the side of the internal shafts 195 and 205 on the straight line 237, the constant velocity joints 196 and 206 remain still even if the internal shafts 195 and 205 tilt responding to rocking of the vehicle body frame 16 in the lateral direction. Accordingly, even if drive shafts 73 and 74 swing together with the suspension arms 71 and 72, the bending angles of the constant velocity joints 196 and 206 can be reduced.

[0114] Third, the present invention is characterized in that the gearbox 81 includes the differential mechanism 172, and in the front and rear of this differential mechanism 172, the right and left internal shafts 195 and 205 are placed.

[0115] This allows easy connection, using a gear and others, the right and left internal shafts 195 and 205 to the left differential axis 173 and the right differential axis 174 being two axes on the output side of the differential mechanism 172, thereby achieving the gearbox 81 compact in size.

[0116] Fourth, the present invention is characterized in that a swing axis and a rocking axis are the same axis, that is, the front part swing axis 136 and the rear part swing axis 85 serve as those.

[0117] By using the swing axis and the rocking axis as the front swing axis 136 and the rear part swing axis 85, the suspension arms 71 and 72 can be placed more inside in the present invention compared with the case of placing any two swing axes away from each other in the vehicle width direction. Accordingly, the suspension arms 71 and 72 can remain long, the right and left rear wheels 18 and 21 can be smaller in tread, and the vehicle width can be reduced. Further, the swing axis and

the rocking axis serve as one axis, whereby the number of the components can be less, and the cost reduction can be thus achieved.

[0118] Fifth, the present invention is characterized in that the pin 187 structuring the differential mechanism 172 passes through the straight line 237.

[0119] By structuring the gearbox 81 including the differential mechanism 172 to rock with the vehicle body frame 16, the inertial moment of the differential mechanism 172 rotating about the straight line 237 as a rotation axis when the vehicle body frame 16 rocks. This is because the pin 187 is locating in the center of the differential mechanism 172. Thereby, for example, the vehicle body frame 16 can rock with a quick motion, successfully increasing the mobility of the tricycle 10 with the rocking mechanism.

[0120] Sixth, the present invention is characterized in that the vehicle body frame 16 includes therein the engine 34, the continuously variable transmission 78, the gearbox 81, and the right and left internal shafts 195 and 205. Accordingly, these components are in such a structure as to rock with respect to the right and left suspension arms 71 and 72.

[0121] When the buffer 76 (refer to Fig. 11) as a suspension spring is provided on the side of the suspension arms 71 and 72, the engine 34, the continuously variable transmission 78, the gearbox 81, and the right and left internal shafts 195 and 205 are not located on the side of the suspension arms 71 and 72. The unspring weight can be thus considerably reduced, and the ride comfort can be better to a greater degree.

[0122] Figs. 2 4 (a) and (b) are both a side view showing another embodiment of the gear train of the gearbox according to the present invention.

(a) shows a gearbox 251 in which the first left gear 176 is engaged with the second left gear 178, the first right gear 177 is engaged with the second right gear 181, the rotation center 234 of the second left gear 178 and the rotation center 236 of the second right gear 181 are placed on the straight line 237, and the straight line 237 is offset upward against the first left gear 176 and the rotation center 235 of the second left gear 177 by an offset amount el. Herein, the distance between the rotation centers 234 and 236 is presumably D2.

As described in the foregoing, by offsetting the straight line 237 upward, the second left gear 178 and the second right gear 181 come closer to the center of the gearbox 251, thereby making the gearbox 251 compact in size. Further, assuming that the height of the straight line 237 from the ground is the same as that shown in Fig. 14, the barycenter of the gearbox 251 can be lower than that of the gearbox 81 of Fig. 14.

(b) shows a gearbox 252 in which the first left gear 176 is engaged with the second left gear 178, the first right gear 177 is engaged with the second right gear 181, the rotation center 234 of the second left gear 178 and the rotation center 236 of the second right gear 181 are placed on the straight line 237, and the straight line 237 is offset downward against the first left gear 176 and the rotation center 235 of the second left gear 177 by an offset amount e2. Herein, the distance between the rotation centers 234 and 236 is presumably D3.

[0123] As described above, by offsetting the straight line 237 downward, the longitudinally-long gearbox 252 can be used if suiting for the device.

[0124] Moreover, in the above (a), (b), and Fig. 14, with the gearbox 251 of (a) and the gearbox 252 of (b), the straight line 237 is offset against the rotation center 235 by a predetermined distance. Thereby, compared with the gearbox 81 of Fig. 14, the distances D2 and D3 can be both shorter than the distance D1. That is, D2 < D1, and D3 < D1. Accordingly, the gearboxes 251 and 252 can be reduced in outer dimension in the fore and aft direction compared with the gearbox 81, and by extension, the tricycle with the rocking mechanism can be shorter in total length.

[0125] The present invention exerts the following effects with the above structure.

[0126] In the rocking vehicle of Claim 1, the right and left output axes are both intersected with the rocking axis, and their intersection points are located in each different position. Accordingly, with such a structure that the right and left output axes each intersect with the rocking axis, through coupling of the right and left output axes with the driving wheels each via a drive shaft, the drive shafts do not displace that much even if the vehicle body frame rocks in the lateral direction. Further, the resulting intersection points of the right and left output axes and the rocking axis are placed in each different position. Accordingly, if the right and left output axes are so provided as to be away from each other in the front and rear of the vehicle body, in the present invention, the drive shafts can be placed extensively in the diagonal direction from the right and left output axes to the driving wheel side. Compared with a case where the right and left output axes are provided on the side part of the transmission or the reduction gear, the drive shaft can be increased in its total length. In consideration thereof, the bending angle of the drive shaft can be suppressed small when the driving wheels move in the vertical direction, and what is better, the tread of the driving wheels can be reduced because the drive shaft is placed extensively in the diagonal direction even if it is long in total length.

[0127] In the rocking vehicle of Claim 2, the driving wheel is coupled to the output axis via the drive shaft including a pair of constant velocity joints, and a bending part of the constant velocity joint on the output axis side is placed on the rocking axis. Accordingly, even if the output axis tilts responding to the vehicle body moving

in the lateral direction, the constant velocity joint remains still. Thus, even if the drive shaft swings together with the suspension arms, the bending angle of the constant velocity joint can be reduced.

[0128] In the rocking vehicle of Claim 3, the reduction gear includes a differential mechanism, and the right and left output axes are placed in the front and rear of the differential mechanism. This allows easy connection of two axes on the output side of the differential mechanism to right and left output axes using a gear and others, thereby realizing the reduction gear compact in size.

[0129] In the rocking vehicle of Claim 4, the swing axis and the rocking axis are the same axis. Thus, the suspension arms can be shorter compared with a case where any two swing axes are so provided as to be away from each other in the vehicle width direction. Accordingly, this reduces the tread of the right and left driving wheels, and narrows down the vehicle width. What is more, the number of components can be reduced, and cost reduction can be thus achieved.

[0130] In the rocking vehicle of Claim 5, the differential pinion axis structuring the differential mechanism passes through the rocking axis. In a case of structuring the reduction gear including the differential mechanism to rock with the vehicle body frame, the differential pinion axis comes to the center of the differential mechanism. Thus, the inertial moment of the differential mechanism about the rocking axis can be reduced when the vehicle body frame rocks. As such, the vehicle body frame can rock with a quick motion, successfully increasing the mobility of the rocking vehicle.

[0131] In the rocking vehicle of Claim 6, through placement of the engine, the transmission, the reduction gear, and the right and left output axes in the vehicle body frame, these components structurally rock against the right and left driving wheels. With such a structure having no engine, transmission, reduction gear, nor right and left output axes on the side of the suspension arms, when a suspension spring is provided on the side of the suspension arms, the unspring weight can be considerably reduced. Accordingly, the ride comfort can be better to a greater degree.

[0132] The axial lines 241 and 242 of right and left internal shafts 195 and 205 are both intersected with a straight line 237 as a rocking axis, and the resulting intersection points 246 and 247 are placed at each different position.

[0133] Through coupling between the right and left internal shafts and rear wheels each via a drive shaft, the drive shafts do not displace that much even if the vehicle body frame rocks in the lateral direction. Further, for example, if the right and left internal shafts are placed away from each other in the front and rear of the vehicle body, the drive shaft can be placed extensively in the diagonal direction from the right and left internal shafts to the rear wheel side. As such, compared with a case where the right and left internal shafts are provided on the side part of the gearbox, the total length of the drive shaft can be increased in the present invention. In consideration thereof, the bending angle of the drive shaft can be suppressed small when the driving wheels move in the vertical direction, and what is better, the tread of the rear wheels can be reduced because the drive shaft is placed extensively in the diagonal direction even if it is long in total length.

Claims

1. A rocking vehicle (10) in which a vehicle body frame (16) is provided with a swing axis (136, 85), right and left suspension arms (71, 72) are attached to the swing axis (136, 85) to freely swing, a driving wheel (18, 21) is attached to each of the suspension arms (71, 72), the vehicle body frame (16) is made rockable by a rocking axis (237) with respet to the suspension arms (71, 72), and an engine output is transferred to the right and left driving wheels (18, 21) via a transmission (78), a reduction gear (81), and right and left output axes (195, 205) provided to the reduction gear (81), **characterized in that** the right and left output axes (195, 205) both intersect with the rocking axis (237), and points of intersections (246, 247) are placed in each different position.

2. The rocking vehicle (10) according to claim 1, **characterized in that** the driving wheel (18, 21) is coupled to the output axis (195, 205) via a drive shaft (73, 74) including a pair of constant velocity joints (196, 198; 206, 208), and a bending part of the constant velocity joint (196, 206) on a side of the output axis (195, 205) is placed on the rocking axis (237).

3. The rocking vehicle (10) according to claim 1 or 2, **characterized in that** the reduction gear (81) includes a differential mechanism (172), and the right and left output axes (195, 205) are placed in the front and rear of the differential mechanism (172).

4. The rocking vehicle according to claim 1, 2 or 3, **characterized in that** the swing axis (135, 85) and the rocking axis (237) are the same axis.

5. The rocking vehicle (10) according to claim 3 or 4, **characterized in that** a differential pinion axis (187) structuring the differential mechanism (172) passes through the rocking axis (237).

6. The rocking vehicle (10) according to any one of claims 1 to 5, **characterized in that**, through placement of the engine (34), the transmission (78), the reduction gear (81), and the right and left output axes (195, 205) on a side of the vehicle body frame (16), the engine (34), the transmission (78), the re-

duction gear (81), and the right and left output axes (195, 205) structurally rock against the right and left suspension arms (71, 72).

Fig. 1

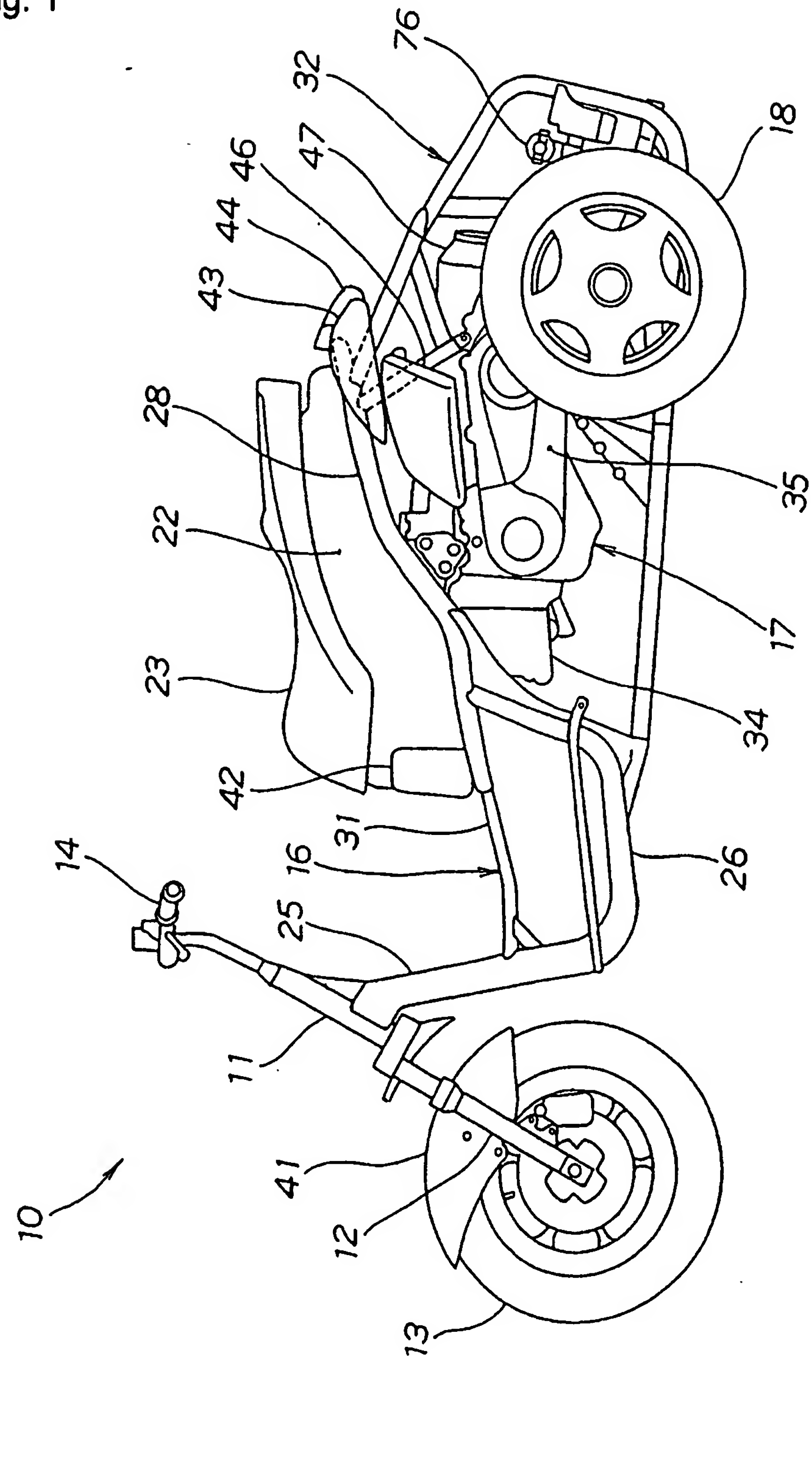

Fig. 2

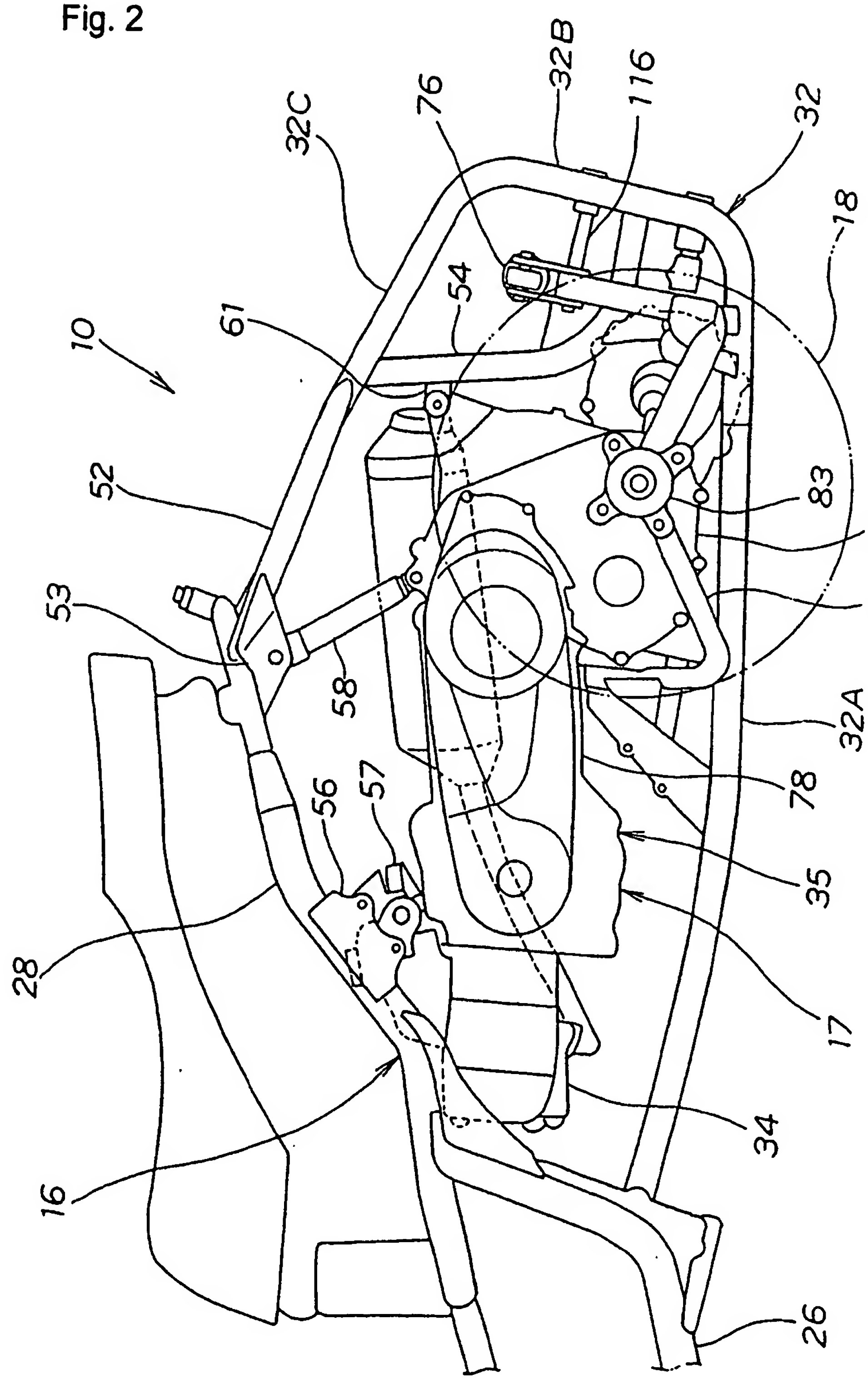
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Fig. 3

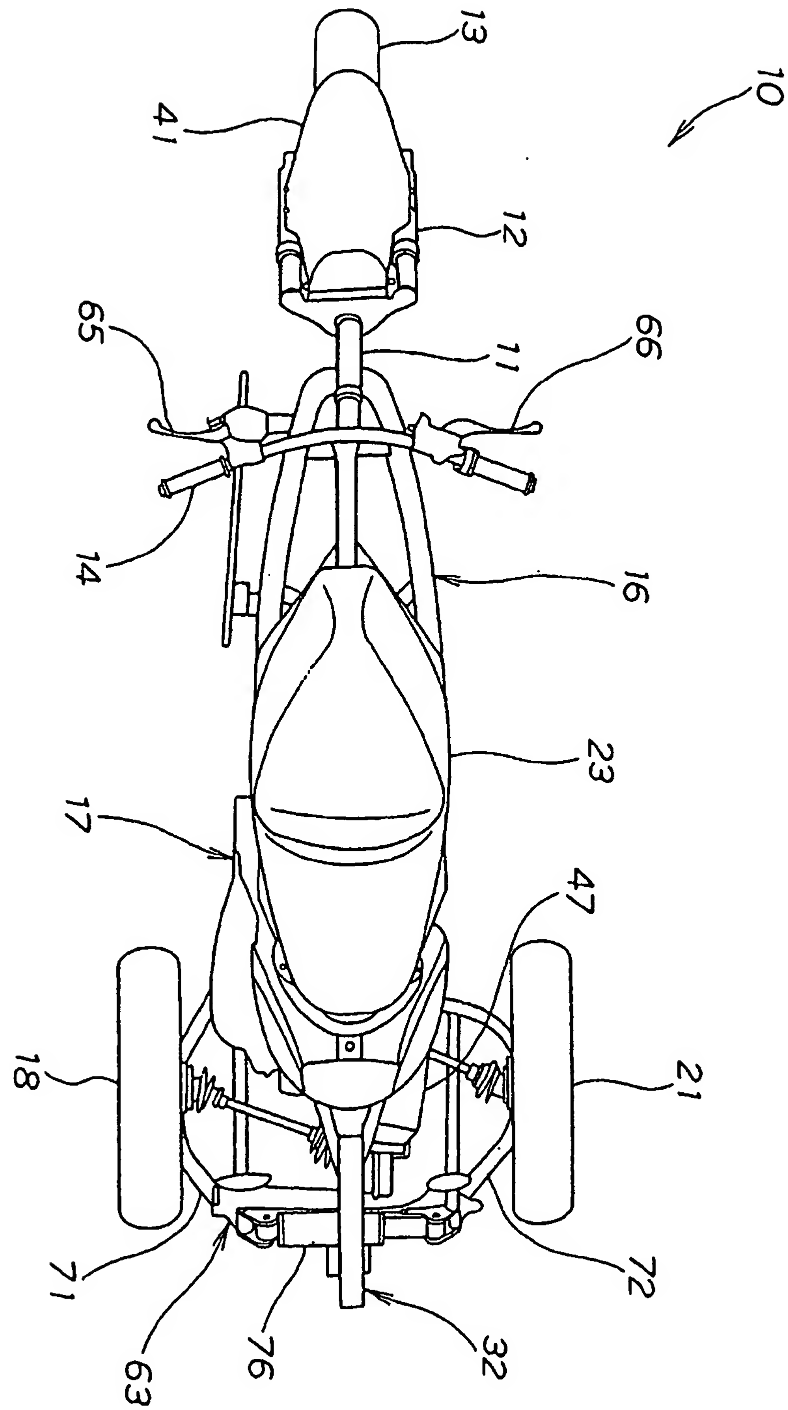

Fig. 4

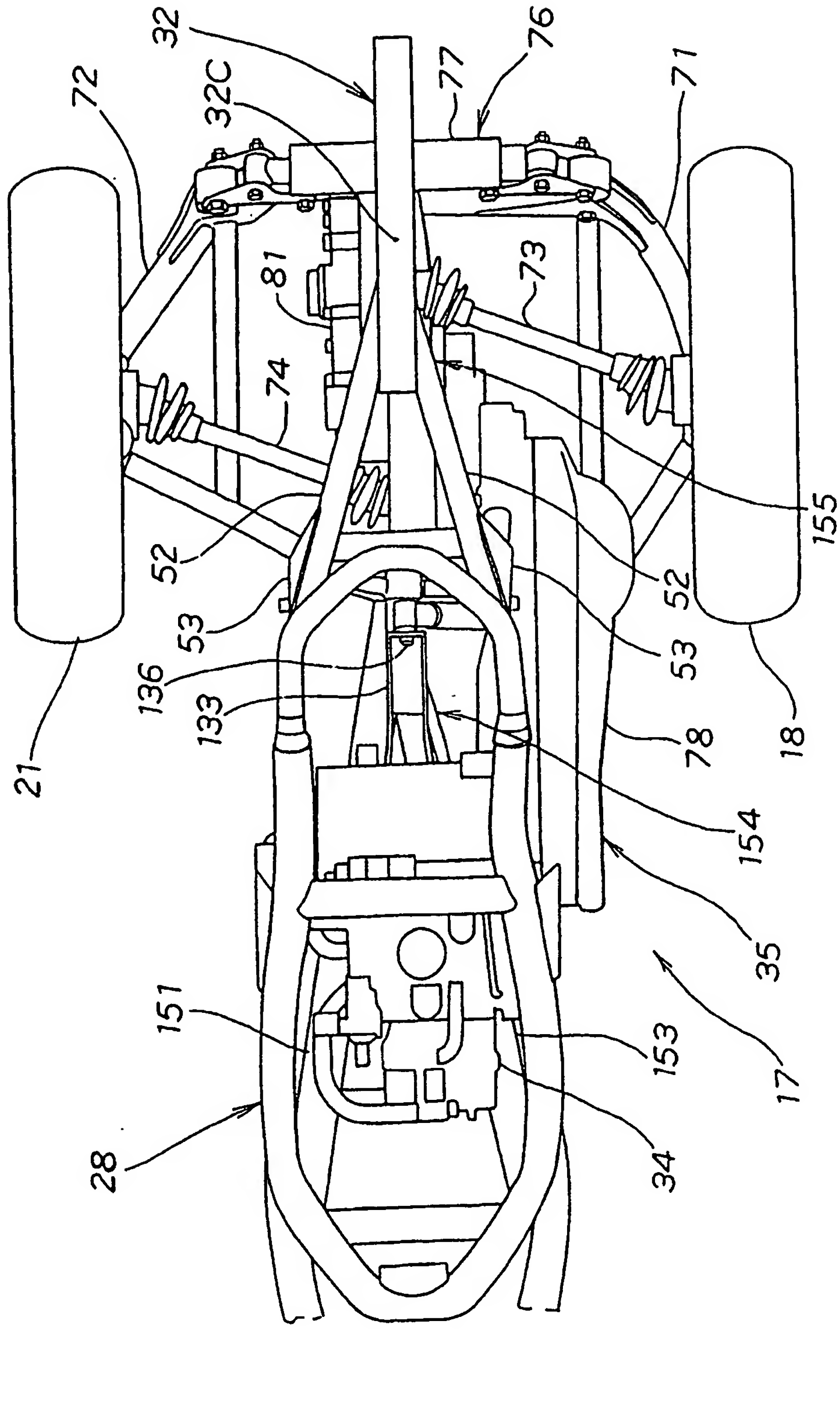
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Fig. 5

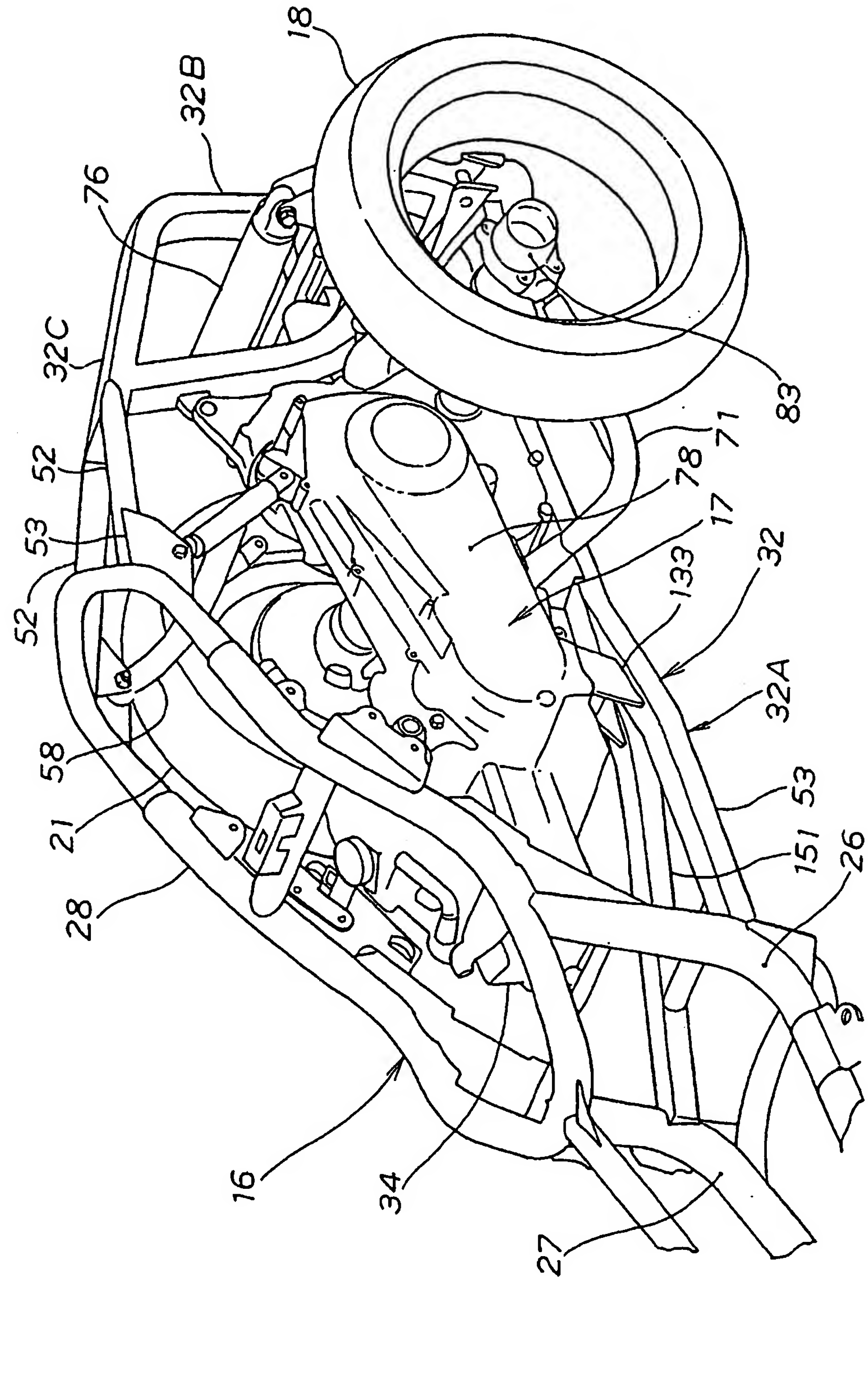
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Fig. 6

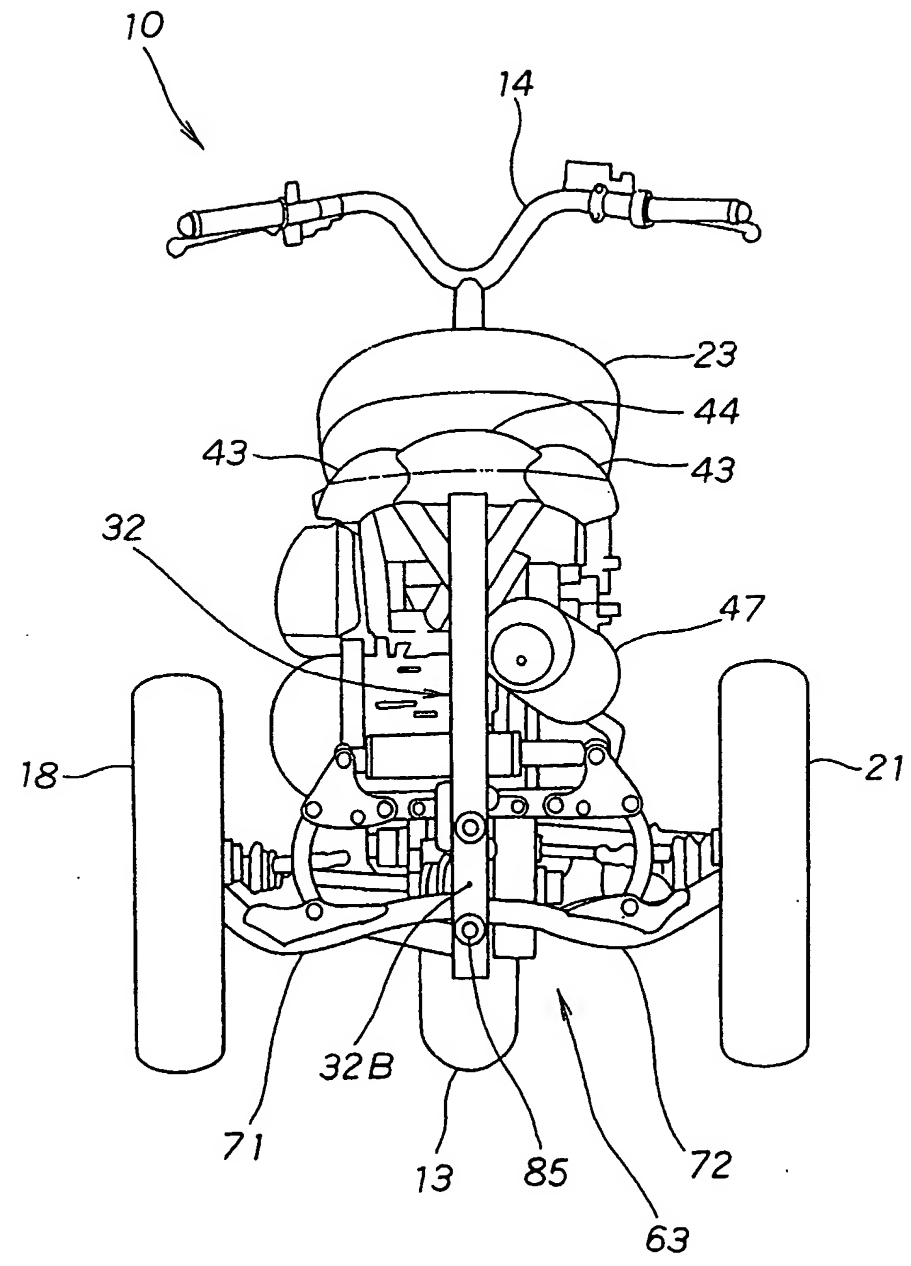
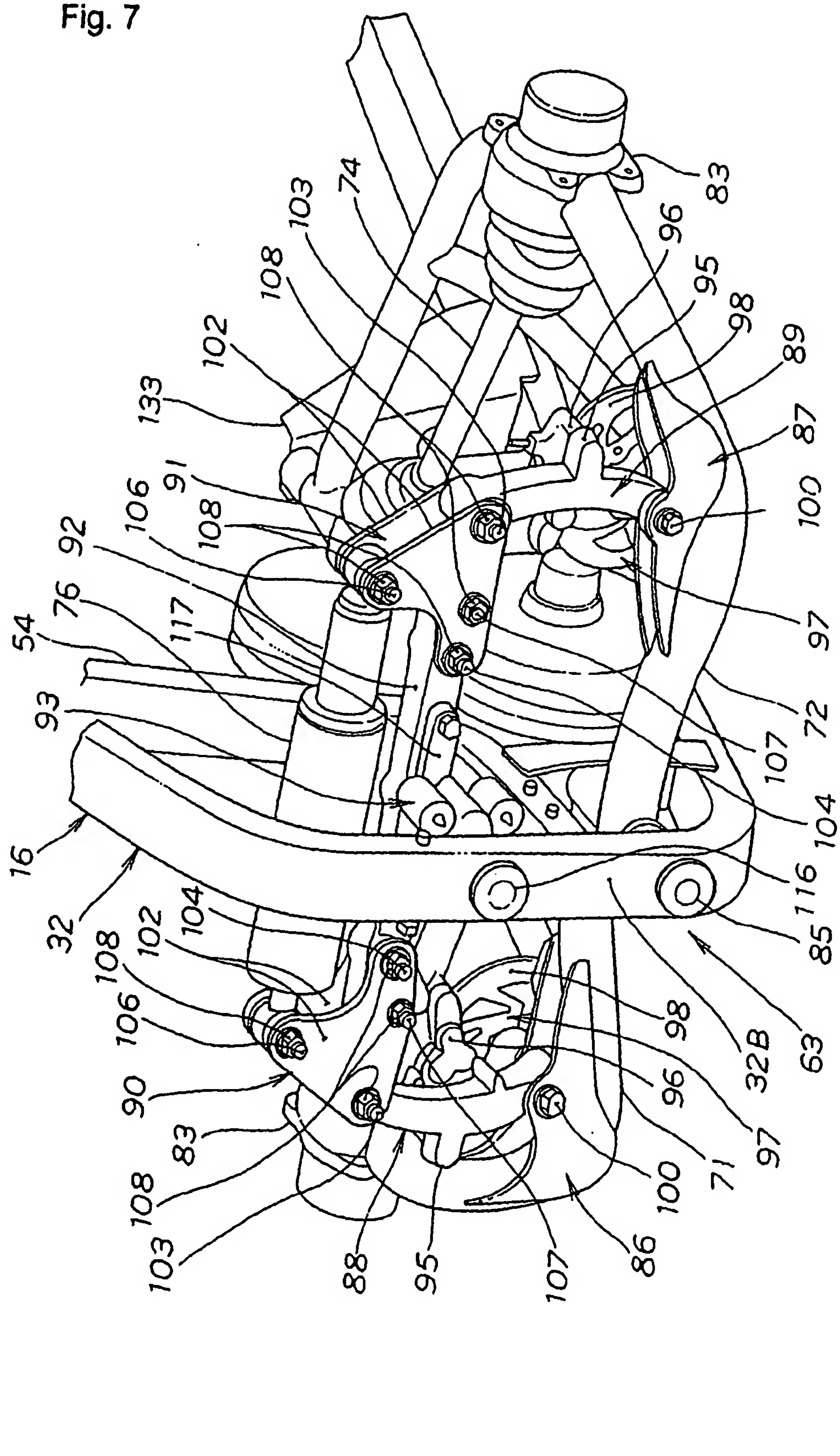


Fig. 7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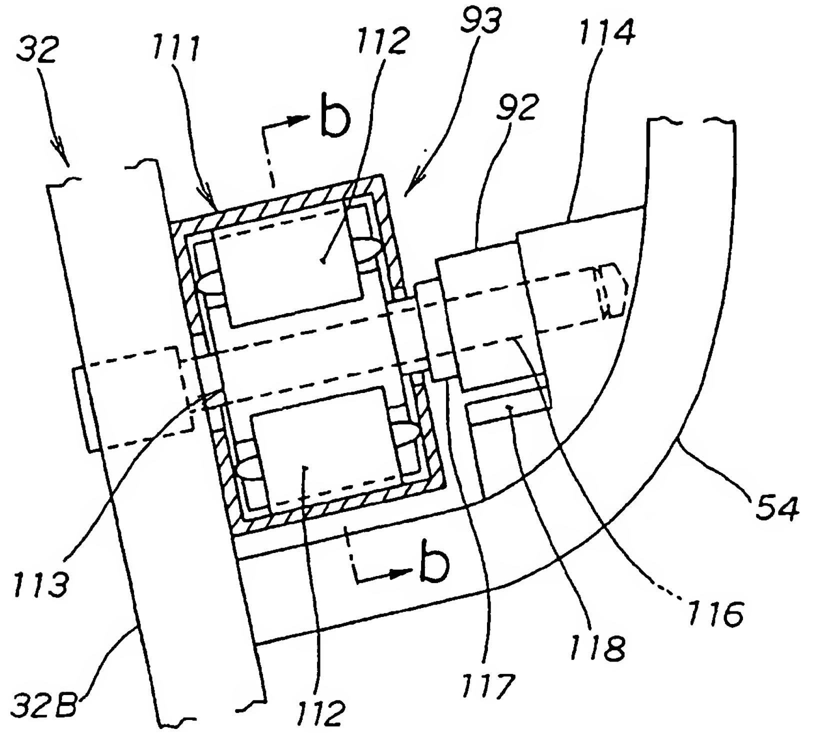
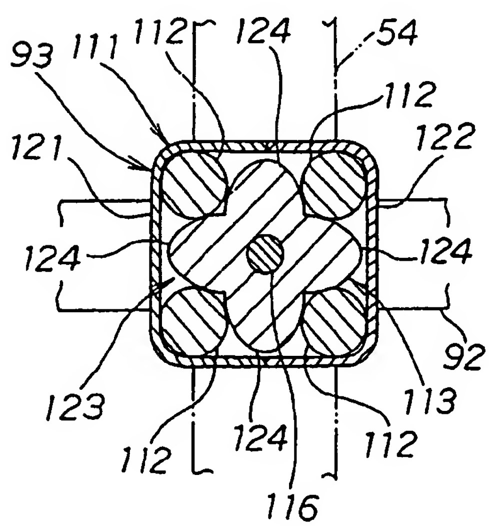
86

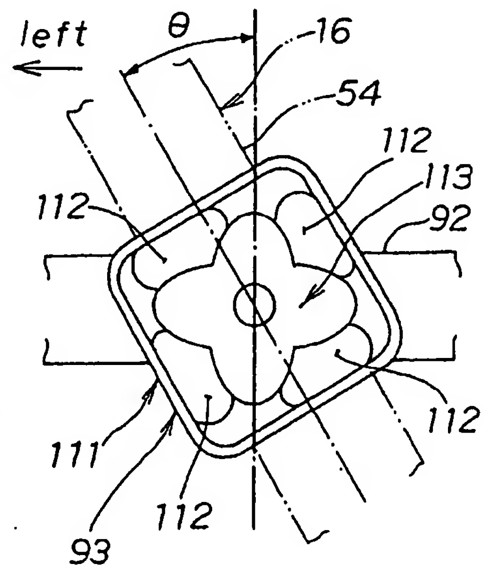
Fig. 8


32
111
112
93
114
b
92
113
b
54
116
118
117
32B
112

(a)


93
111
112
124
54
112
121
122
124
124
123
92
113
112
124
112
116

(b)


left
θ
16
54
112
112
113
92
112
111
112
93

(c)

Fig. 9

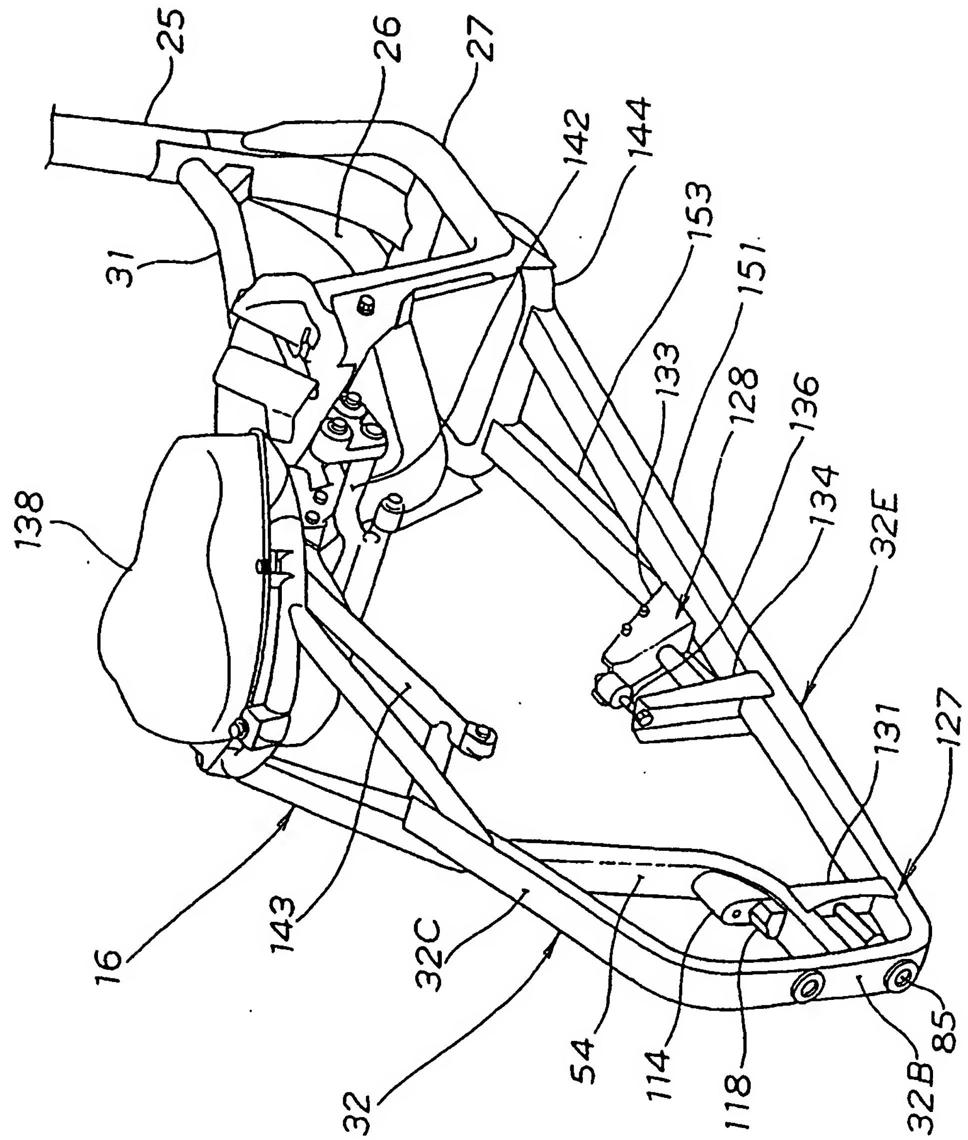

25
26
27
142
144
153
151
31
133
128
136
134
32E
138
131
127
16
143
32C
32
54
114
118
32B
85

Fig. 10

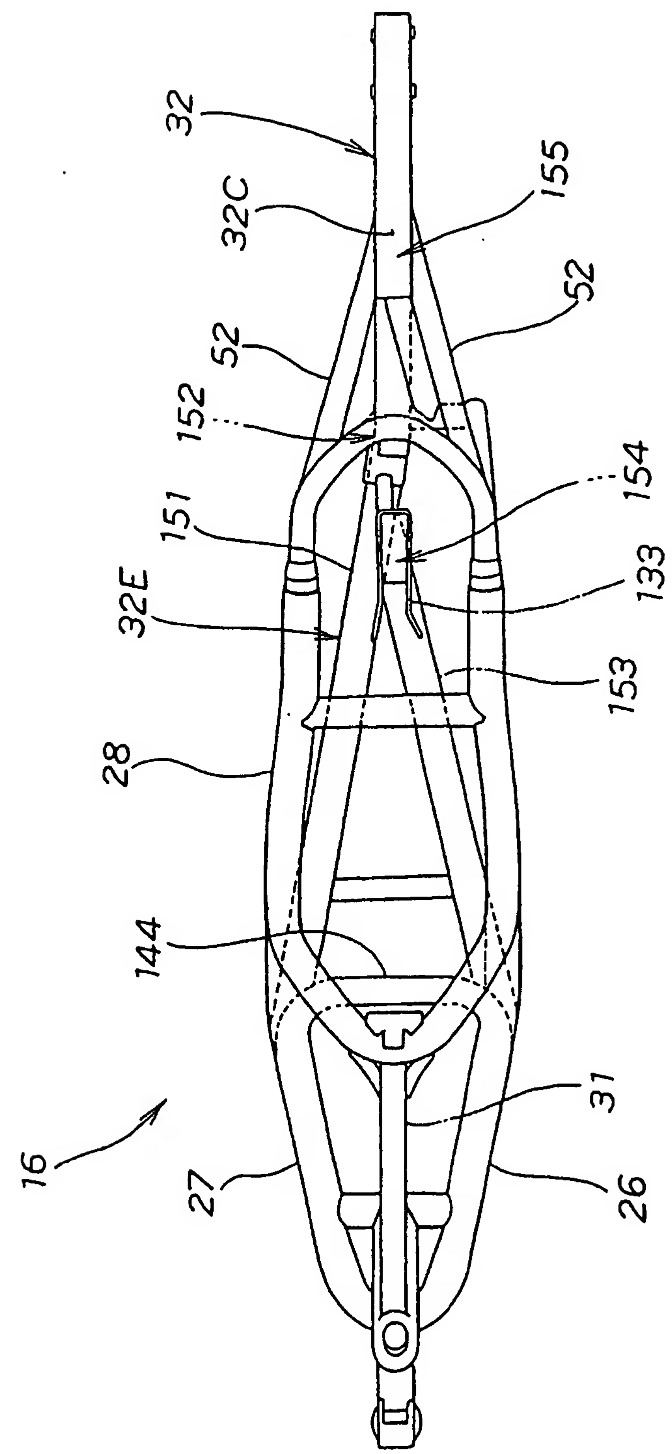


Fig. 11

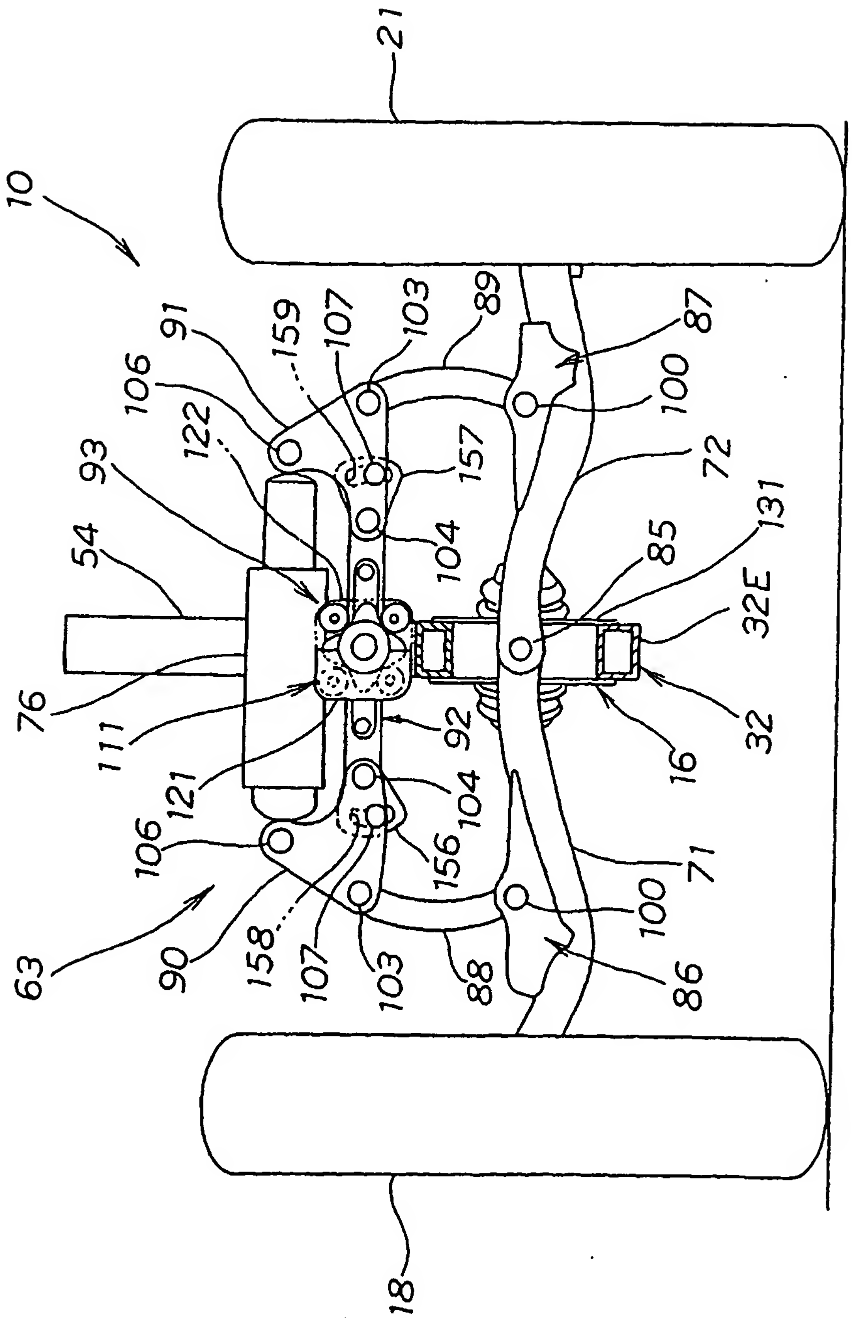

10
21
91
106
159
107
103
89
87
100
122
93
157
72
54
104
85
131
32E
76
111
92
16
32
121
106
156
71
63
90
158
107
103
88
86
18

Fig. 12

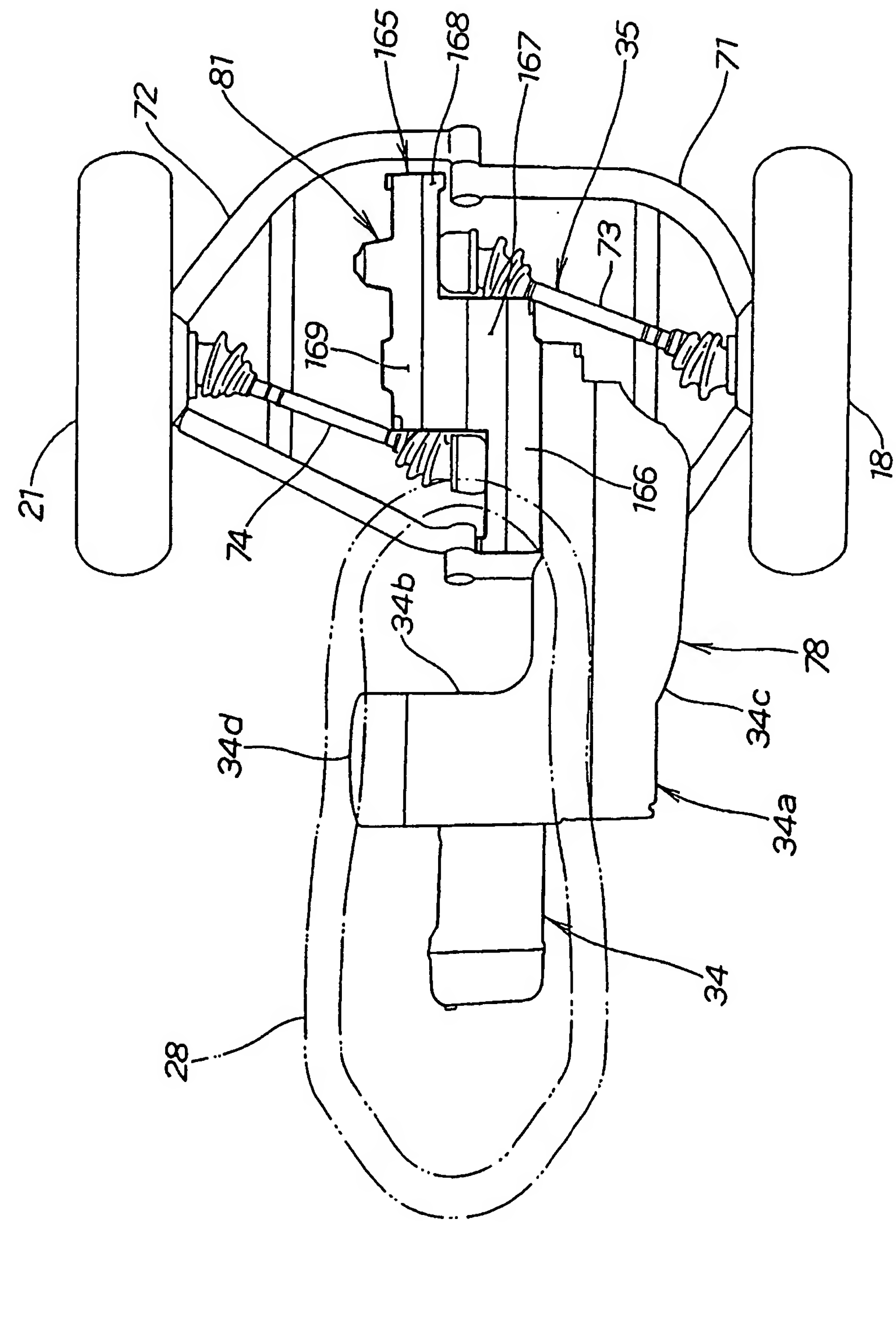
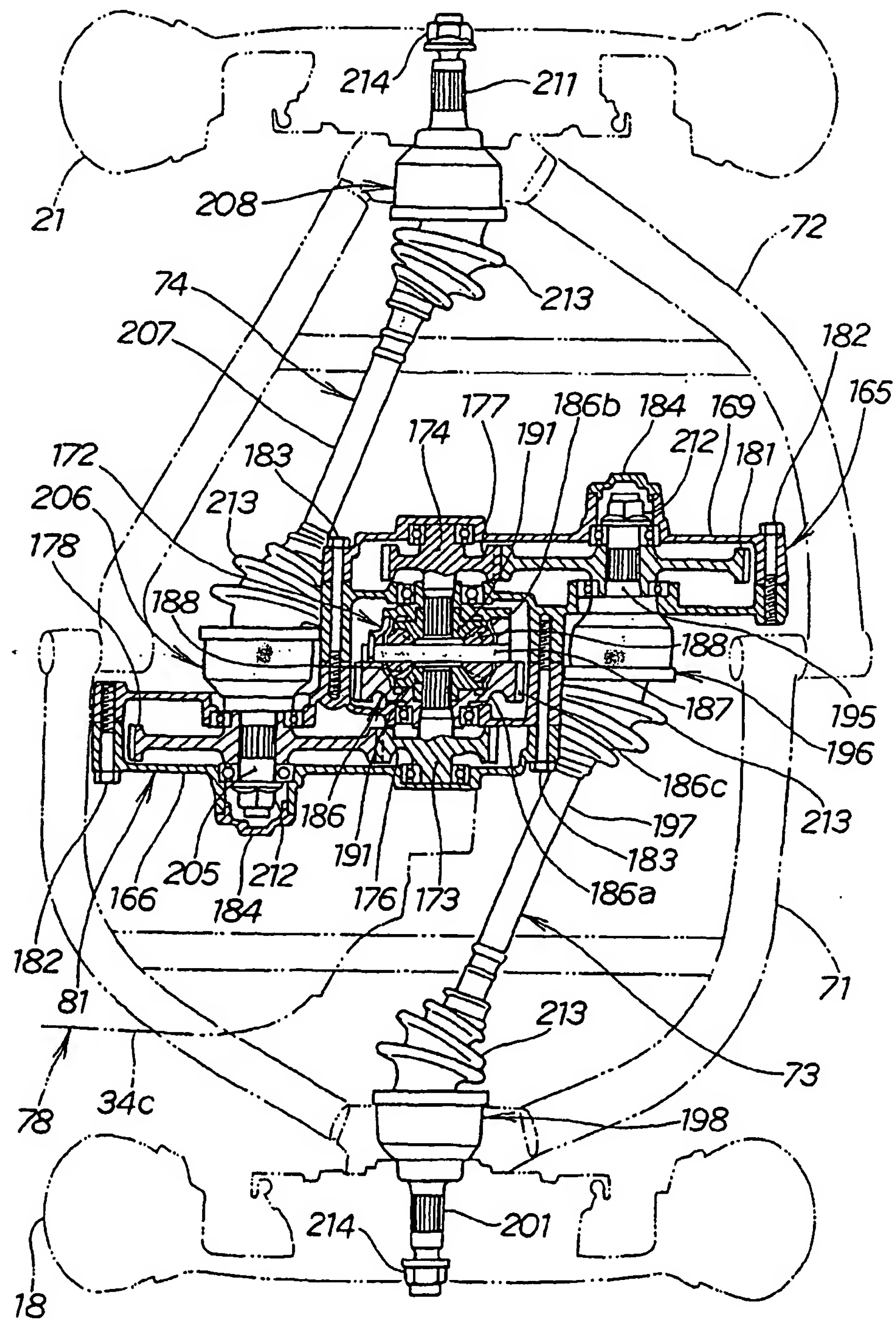


Fig. 13



214
211
21
208
72
74
213
207
182
165
177
186b
184
169
174
191
212
181
172
183
206
213
178
188
188
195
187
196
186c
213
197
183
186
191
176
173
186a
205
212
166
184
182
81
71
213
73
78
34c
198
214
201
18

Fig. 14

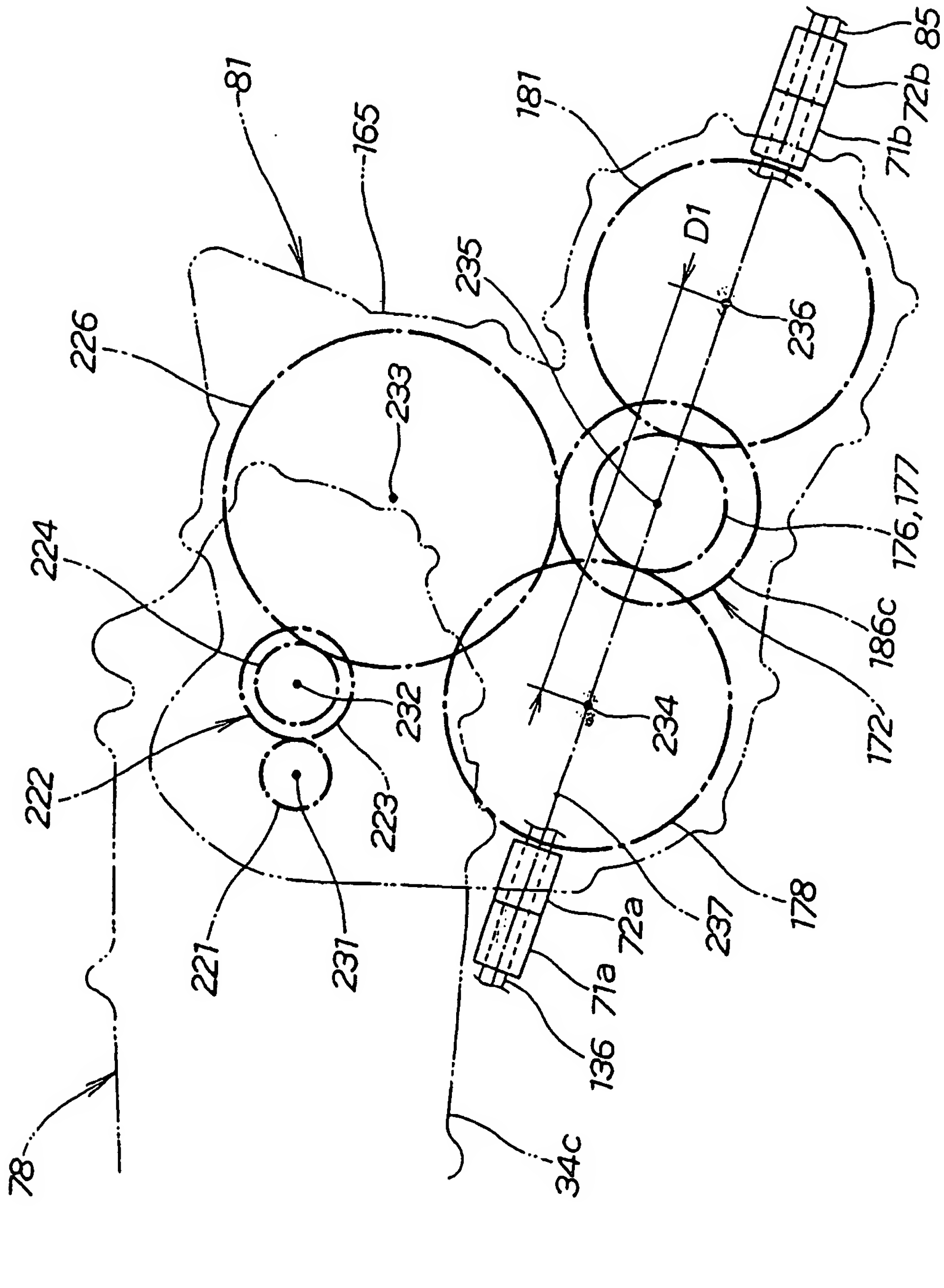

81
165
181
85
72b
71b
D1
235
236
226
233
176,177
224
186c
172
232
234
222
223
178
221
231
237
72a
71a
136
34c
78

Fig. 15

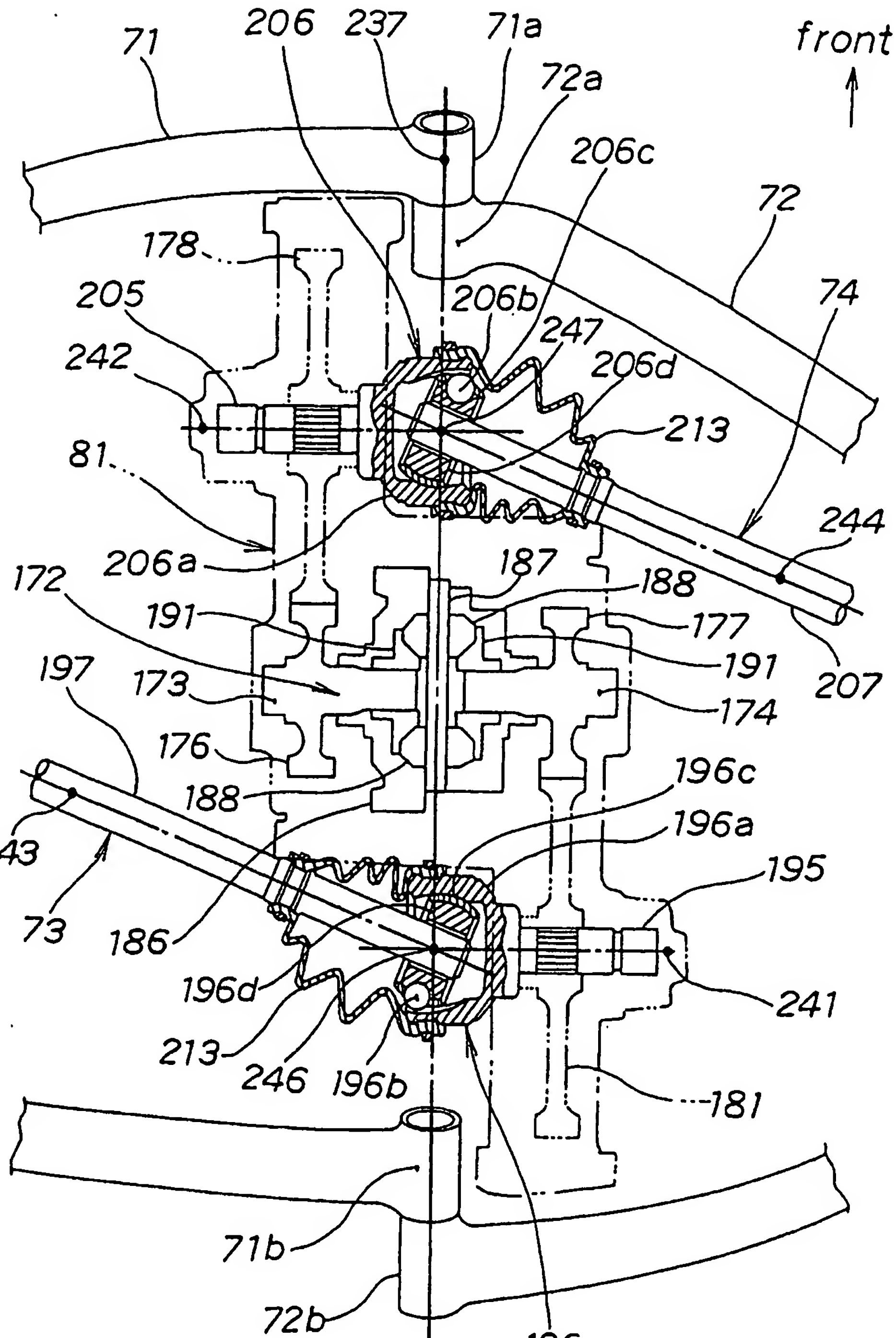

front
71
206
237
71a
72a
206c
72
178
205
206b
74
242
247
206d
213
81
244
206a
187
172
188
191
177
191
197
173
174
207
176
196c
188
196a
243
195
73
186
241
196d
213
246
196b
181
71b
72b
196

Fig. 16

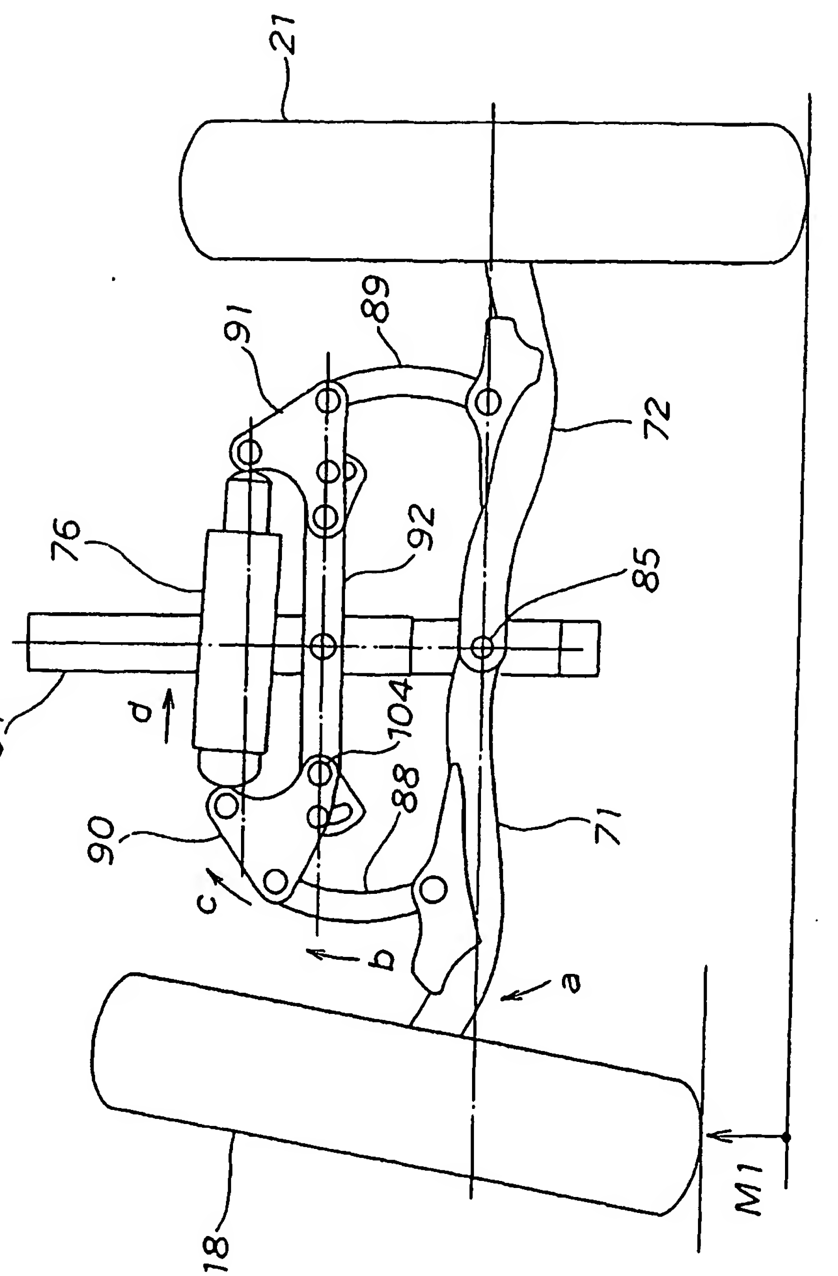


Fig. 17

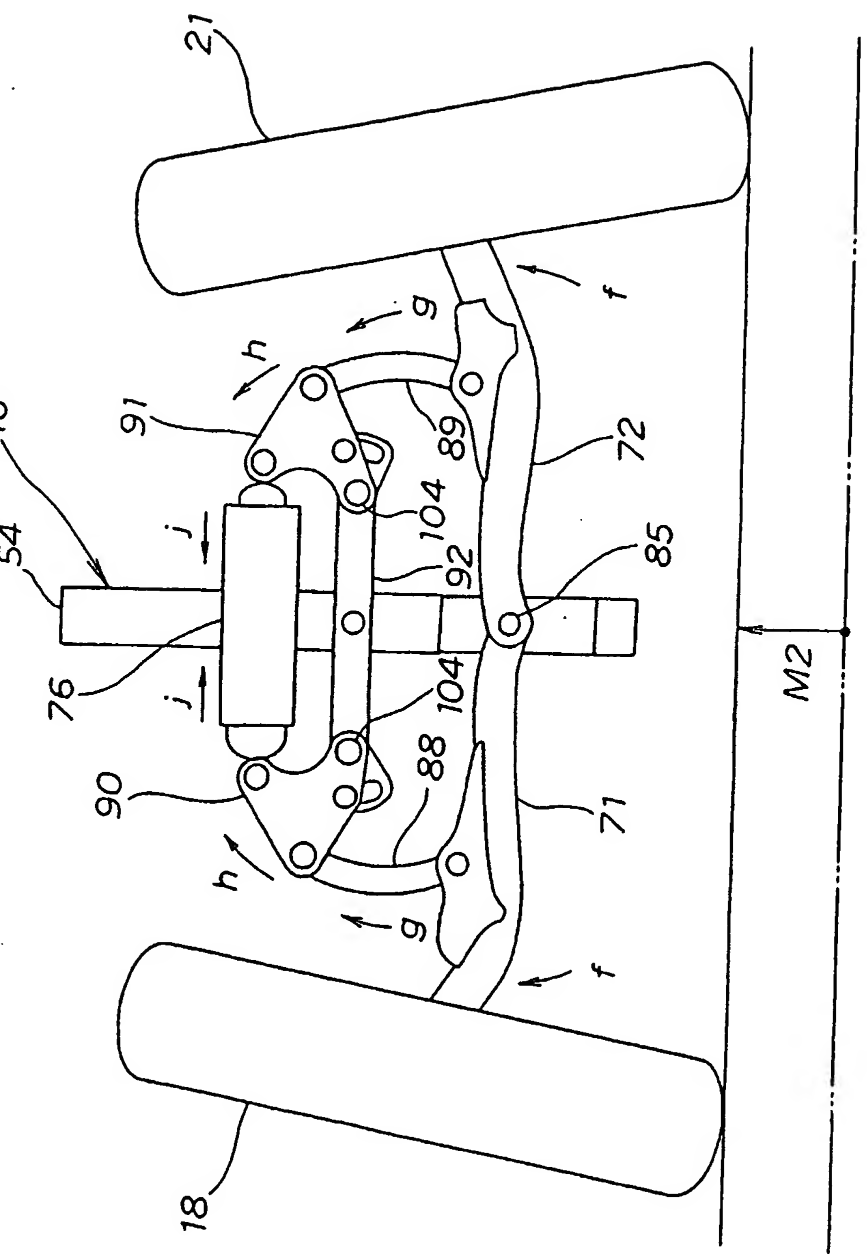


Fig. 18

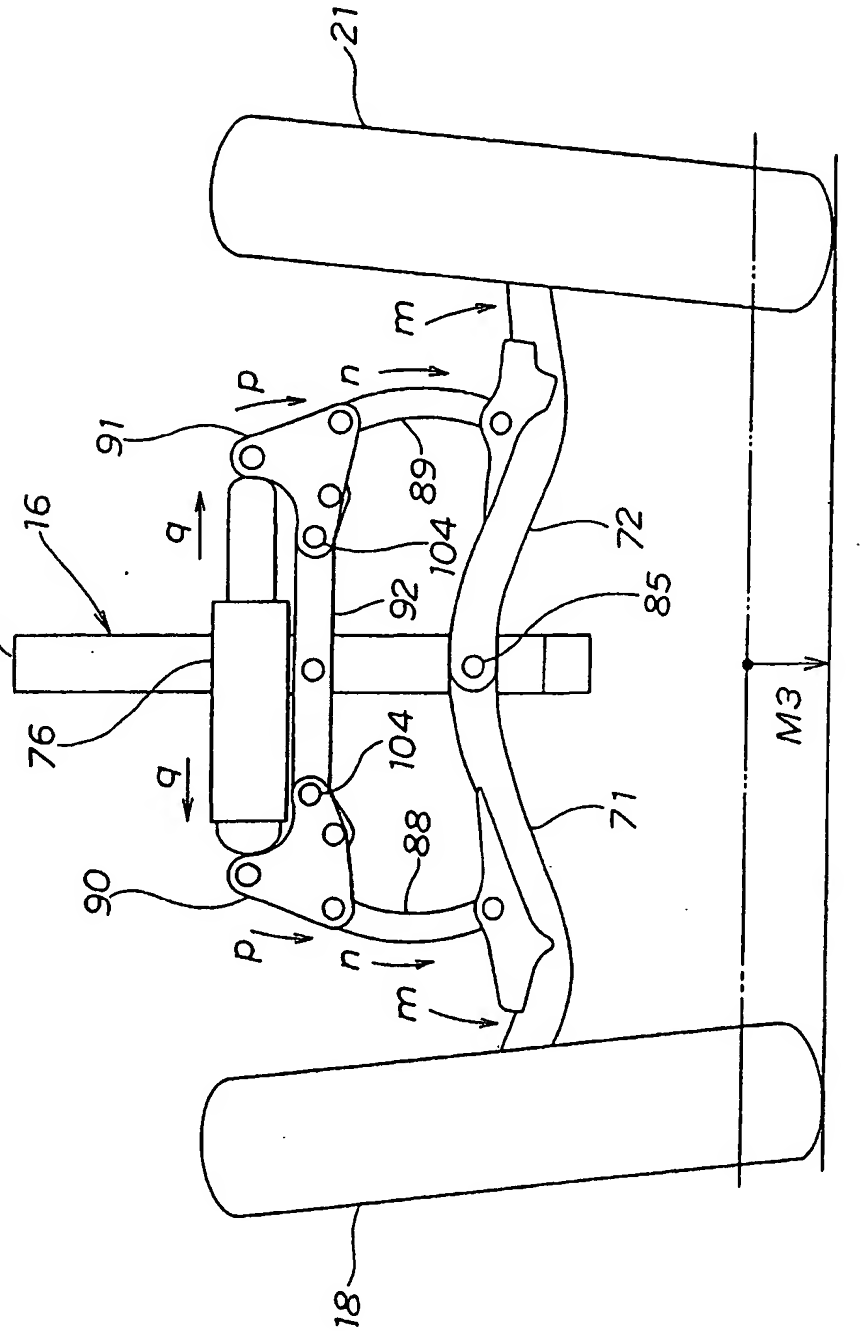


Fig. 19

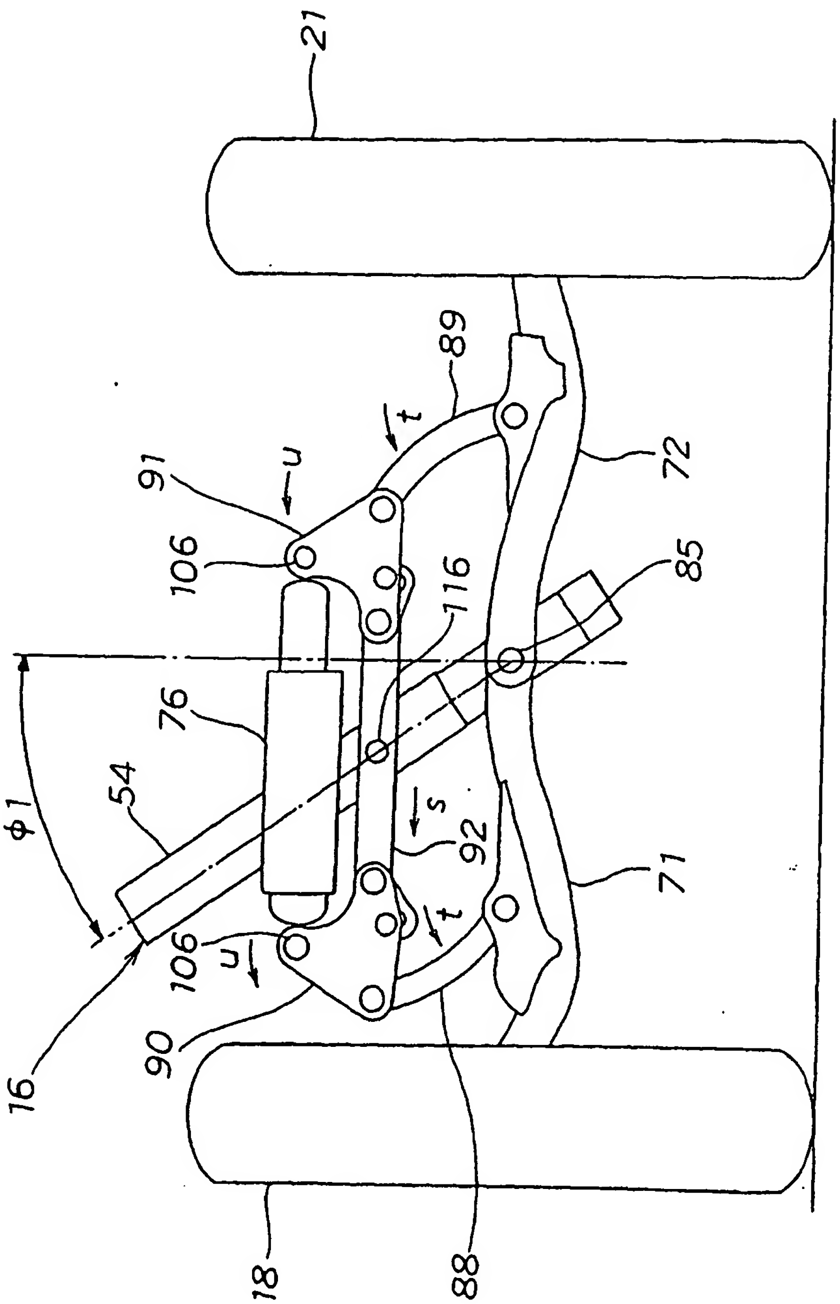


Fig. 20

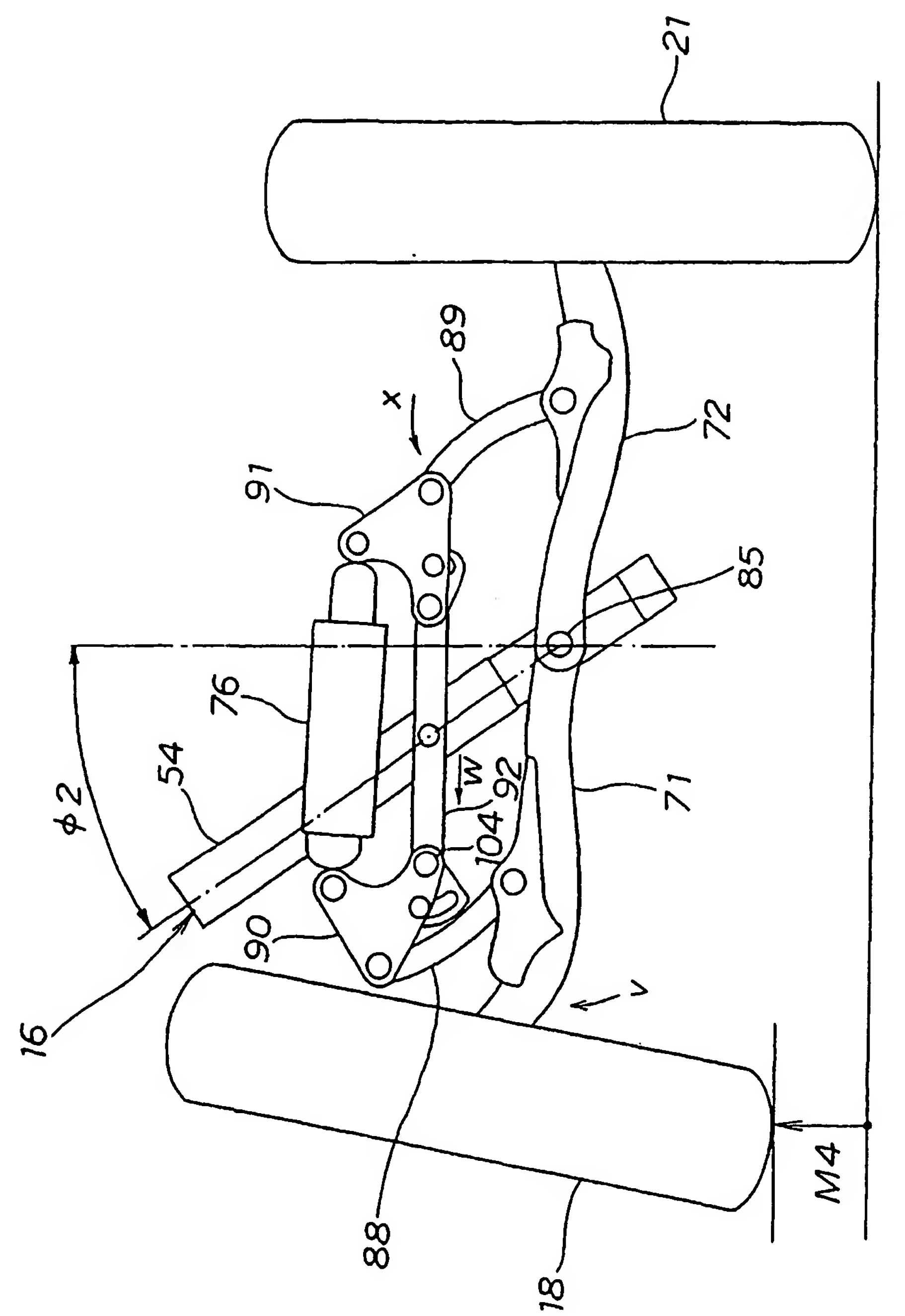
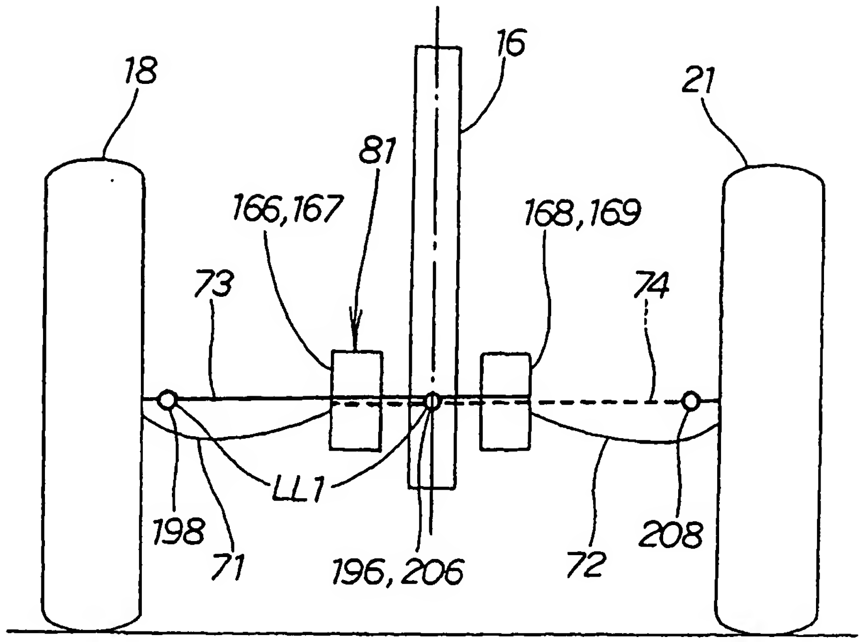
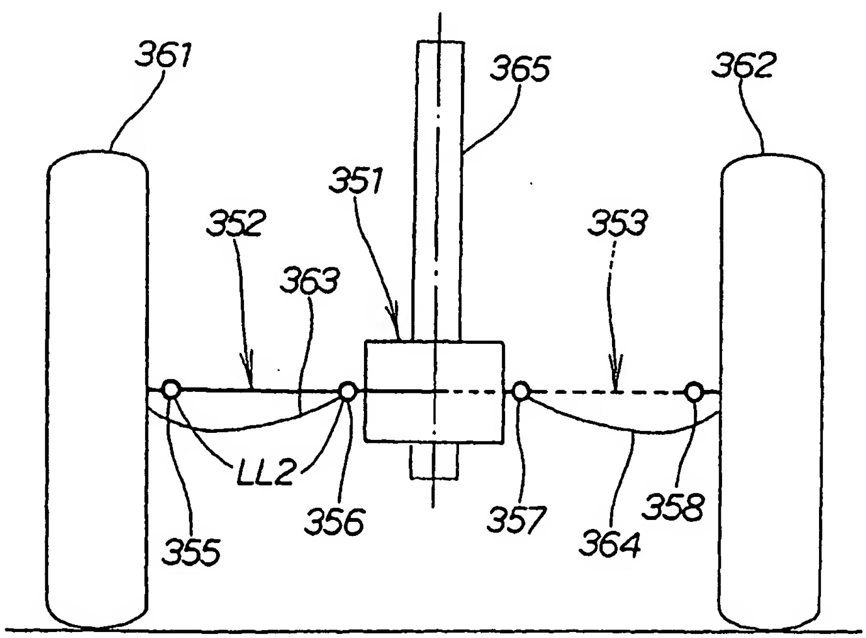


Fig. 21



(a) EXAMPLE



(b) COMPARISON EXAMPLE

Fig. 22

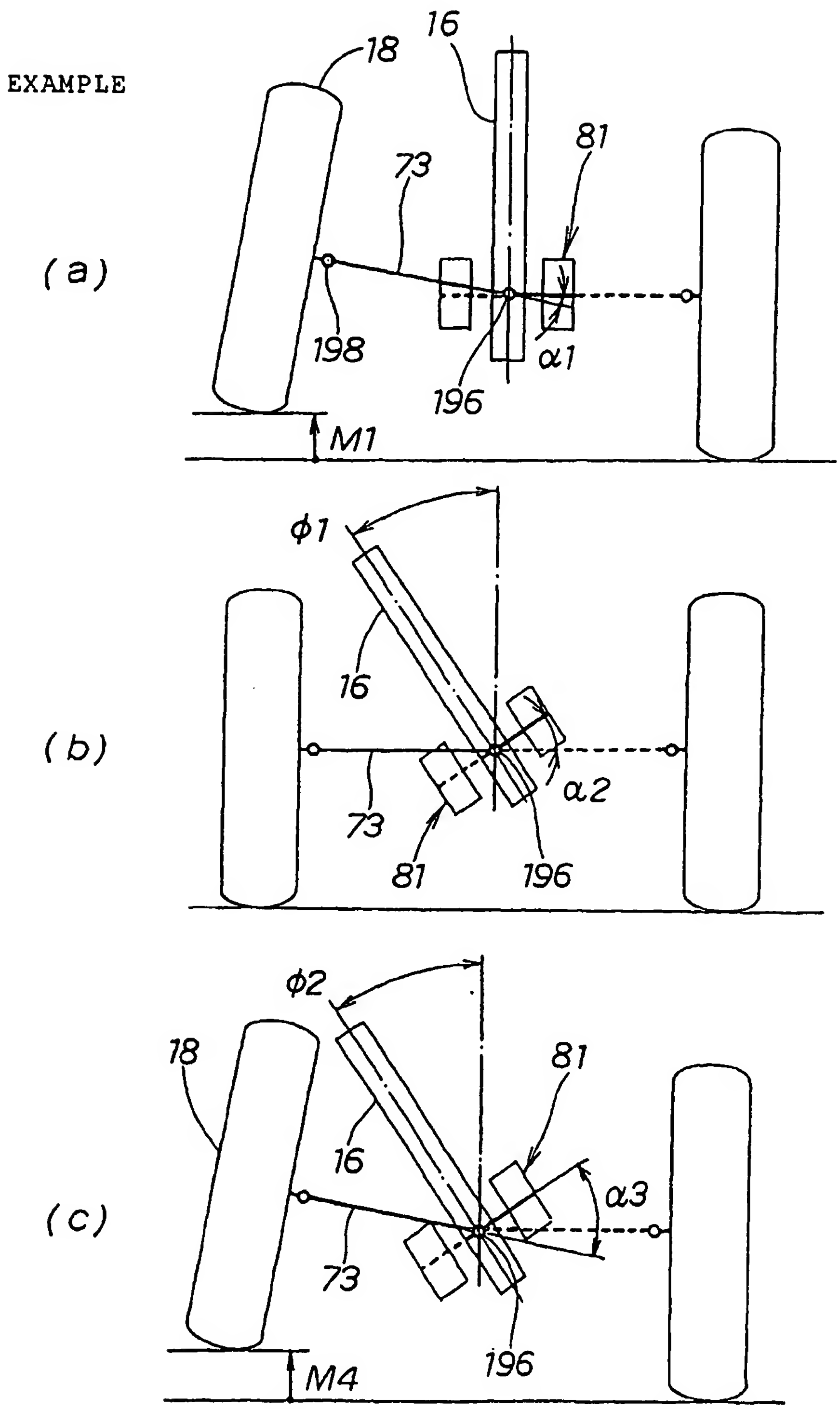

EXAMPLE
(a)
18
16
81
73
198
196
α1
M1
(b)
φ1
16
73
81
196
α2
(c)
φ2
18
16
81
α3
73
196
M4

Fig. 23

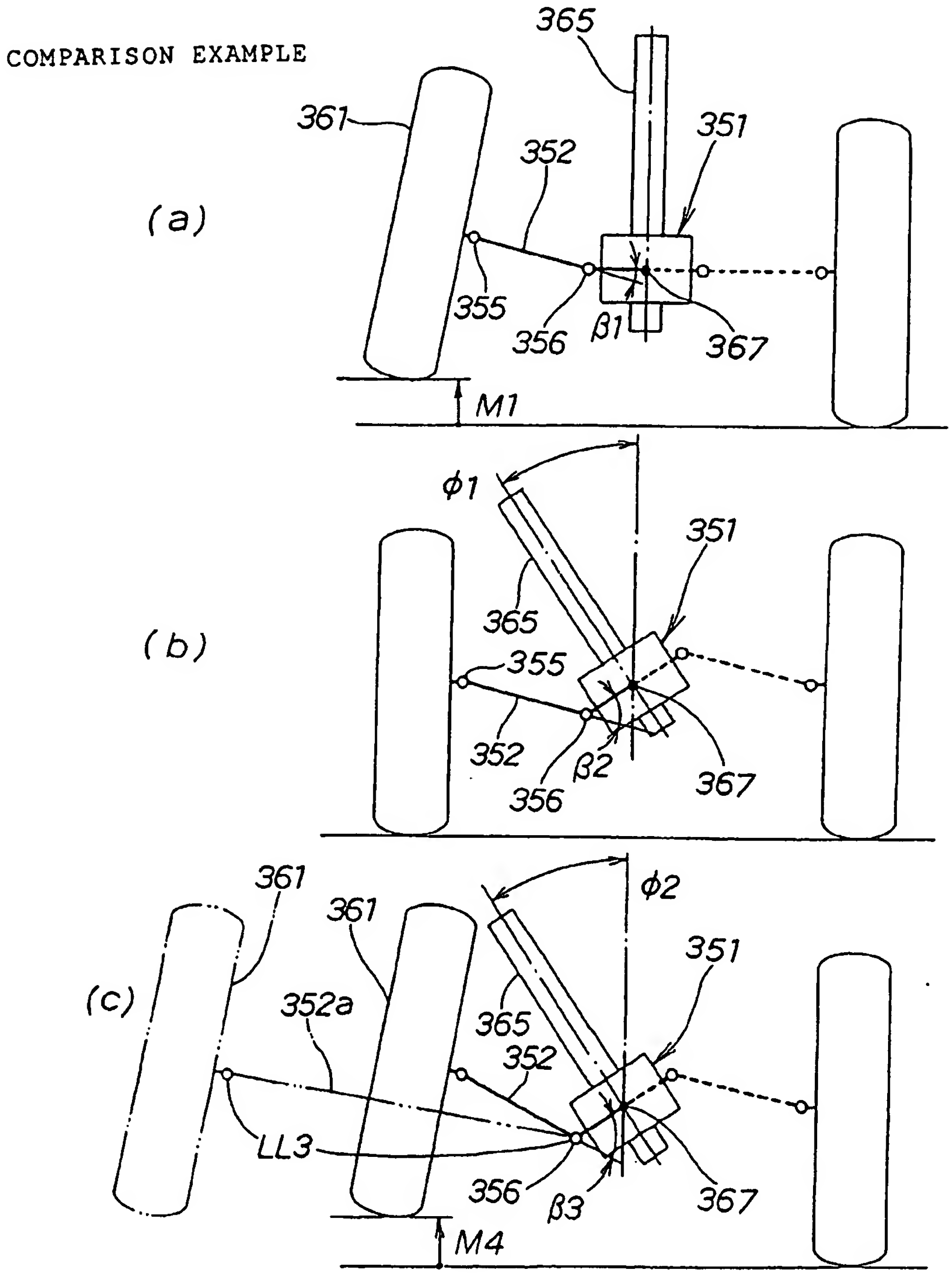

COMPARISON EXAMPLE
(a)
365
361
352
351
355
356
β1
367
M1
(b)
φ1
351
365
355
352
β2
356
367
(c)
361
361
φ2
351
352a
365
352
LL3
356
β3
367
M4

Fig. 24

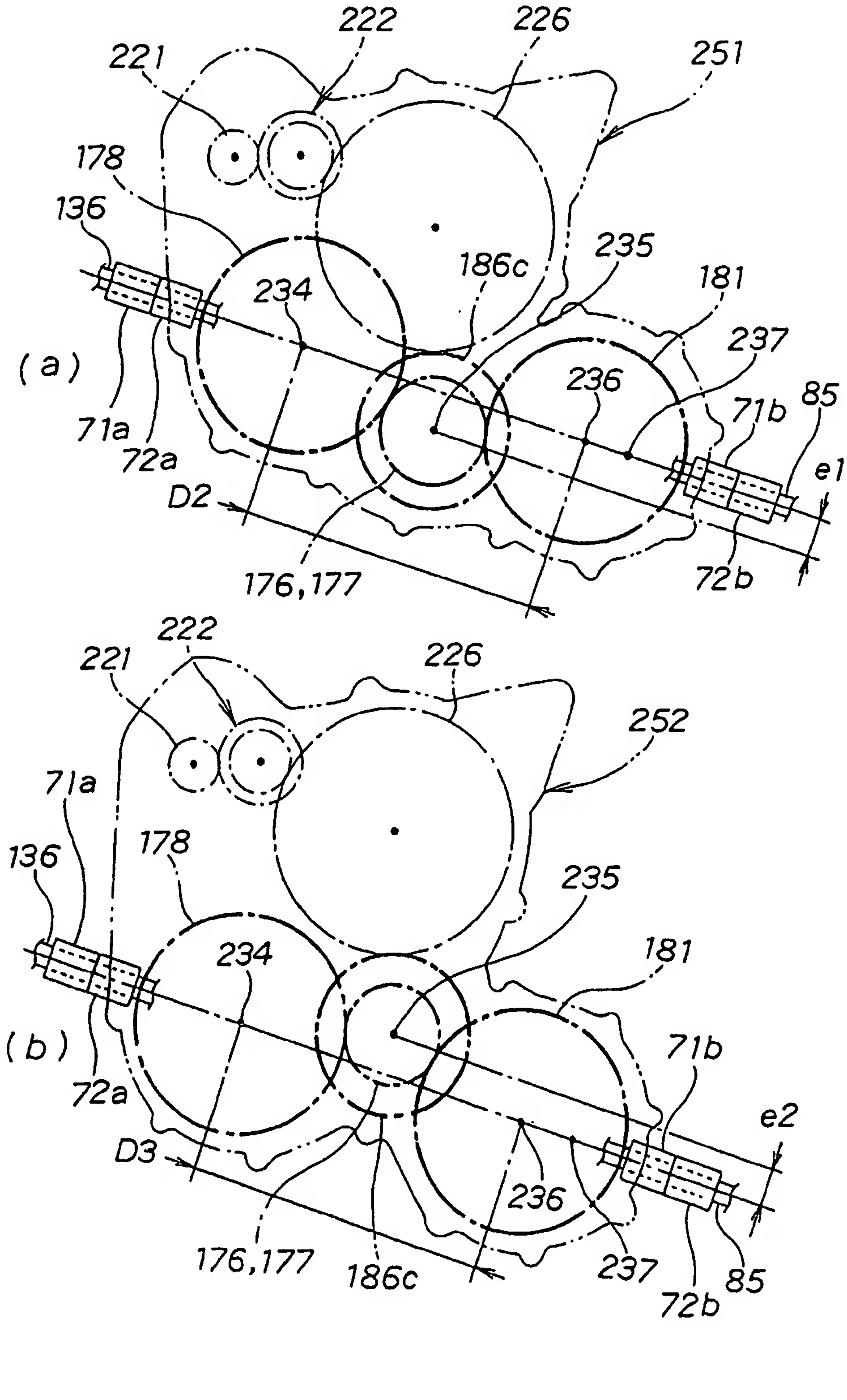

222
226
221
251
178
136
186c
235
234
181
237
(a)
236
71b
85
71a
72a
e1
D2
176,177
72b
222
221
226
252
71a
178
136
235
234
181
(b)
71b
72a
e2
D3
236
176,177
186c
237
85
72b

Fig. 25

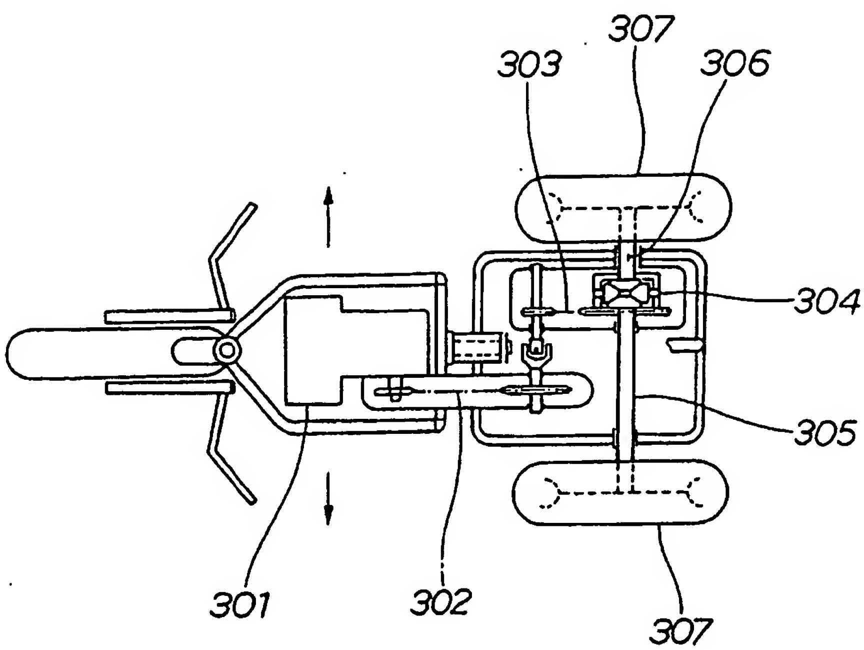


Fig. 26